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PAINT MAKING AND COLOR GRINDING

PAINT MAKING

AND

COLOR GRINDING

A PRACTICAL TREATISE FOR
PAINT MANUFACTURERS
AND FACTORY MANAGERS

Including Comprehensive Information Regarding Factory Arrangement; Pigments; Vehicles and Thinners; Liquid and Cold Water Paints as well as Practical Working Formulas and Recipes.

BY CHARLES L. UEBELE

NEW YORK
The Painters Magazine
100 William Street

LONDON
The Trade Papers Publishing Co., Ltd.
365 Birkbeck Bank Chambers, W. C.

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December, 1913

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Printed by
ADAMS & GRACE COMPANY,
22 Thames Street, New York.

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PUBLISHERS' PREFACE

ALTHOUGH many books have been published on the subject of paint and pigments, most of them have been written either by chemists, whose knowledge of the practical questions involved in paint manufacturing has been more or less biassed by the standards of the laboratory; or they have been written from the viewpoint of the consumer or practical painter; or in many instances they have been mere collections by hack writers of formulas that have appeared many times previously, and therefore being entirely out of date, whatever value they may have originally possessed has been lost, because later and better methods and formulas have been introduced into the paint factory.

In no other country have the advances in paint making and color grinding been so rapid as in the United States, because in no other country are such enormous quantities of paint consumed; and this is natural, because nowhere else are such a large proportion of the houses built of wood, requiring protection by paint in order to preserve them from the ravages of the elements. Owing to the competition that exists between the different paint manufacturers, processes have been gradually improved and developed until the practices of a decade ago have been completely revised or supplanted by more modern methods. Up to the present time, no book has been written from the standpoint of the practical paint factory man, and for the use of the manufacturer, as distinguished from the paint chemist.

We have frequently had calls for a book describing the latest methods of paint making and for this reason, we have felt that a work of the character of the present one would meet a necessity which exists.

The author of the present book, Mr. Charles L. Uebele, while by no means a novice in paint trade literature, has always been too modest to permit his name to appear in connection with the numerous articles which he has contributed to various paint

trade publications, especially to *The Painters Magazine* and the *Oil, Paint and Drug Reporter*, but we have prevailed upon him to permit this book to be issued under his name.

Mr. Uebele has been connected with paint manufacturing for upwards of twenty-five years, and for the greater part of that time has been in charge of the paint making and color grinding in one of the largest factories of this country. For the past three years, he has been identified actively with a company engaged in the manufacture of paint specialties, specification paints and cement coatings. His work has not only been along practical lines, involving the handling of men, machinery, and materials, and a knowledge of the latest improvements in every process used in the paint factory, but it has necessitated much original research in order to develop such improved methods as were needed to keep the products of the factory with which he was identified at the forefront, as well as constant practical tests of their own and their competitors' products. Although well acquainted with the technical and scientific side of paint making, Mr. Uebele is essentially a factory manager and has written this book for other men holding similar positions. The methods given have all been practically tested out and are those in use in up-to-date factories at the present time. The formulas given in Part VI, have never been published before and are of themselves worth to the paint manufacturer, many times the cost of the book. Indeed, practical working formulas of this character are generally sold—when they can be bought at all—at prices ranging from ten dollars to twenty-five dollars each, and even more.

In offering this book to the paint manufacturers, we do so with absolute confidence that the statements made in it are correct and represent the best practice in paint making and color grinding at the present time.

THE PAINTERS MAGAZINE.

December, 1913.

AUTHOR'S PREFACE

IN presenting this volume to the consideration of practical men and others interested in the subject of paint making and color grinding, it has been the aim of the author to incorporate the results of almost a life time of work and study of paint problems, in a way that should be readily understood by interested readers. It is not the object of the author to tell the reader, how to make inferior goods for the purpose of gain. If he looks for such information he will have to work this scheme out for himself. The idea of the work is to show, how economy can be practiced and rational methods adopted, so that high grade or standard goods may be produced and reputation maintained in the face of competition.

The author, from the very start in his career, nearly thirty years since, when in the employ of one of the oldest firms in this country, has had the good fortune to be associated with technical men, who endeavored to have the very best products it was possible to manufacture. To these associations, and with the aid of a well equipped chemical laboratory and its learned chief, is due the author's ability to offer a work of this character, which has been written only after much persuasion by friends in the trade. It is the hope of the author, that the work will be favorably received and serve as a volume of reference to practical men and as a handbook for beginners.

In presenting the formulas in Part VI as well as those in the body of the book, the author desires to say to those, who are yet unfamiliar with the practical work in a paint factory, not to condemn a formula or suggestion, when it does not appear successful at the first attempt, but to think it over with a view to discover, where an error might have been made. After all, while formulas are of great assistance to the practical man, a certain knack in manipulation is essential to success.

CHARLES L. UEBELE.

December, 1913.

Paint Making and Color Grinding

CHAPTER I.

THE FACTORY AND ARRANGEMENT.

Before describing in detail the processes involved in paint making and color grinding, it is well to consider briefly the general arrangement of the plant, the necessary machinery, apparatus, storage and facilities for handling the raw material and requirements for shipping the finished products.

The writer is well aware, that much will depend upon the capital that is available and the size and capacity of the plant, and whether it is contemplated building a new factory, where all conditions can be planned and controlled from the very start, or whether an old factory must be used with machinery in operation, that is still too good for the scrap heap, or where conditions of site will not permit desirable or modern arrangements, yet it is possible to point out ideas from which the paint manufacturer may approximate plans to improve upon existing conditions.

It may be well to state right here, that true economy will often consign to the scrap heap a mill, mixer or other apparatus, that might be still used for years, but at the expense of yield in production, quantitatively and qualitatively. By working with antiquated apparatus, it is difficult to compete with those owning modern equipped plants and it has been asserted by those who have made efficiency a study, that more

paint and other factories have failed, because of the use of antiquated machinery and systems or processes, than from any other cause.

In selecting a site for a plant, the first consideration, of course, should be facilities for transportation with opportunity to introduce railroad sidings, if the size of the output warrants such, or at least close proximity to shipping terminals, because cartage is quite an item of expense.

As to the factory building or buildings, the arrangements should be such, that really only the storing of the raw material should require any amount of power, while the progress of the material during the process of manufacture should be accomplished by gravity. Hence, wherever a factory building is of sufficient height, it should be so substantial that the heavy raw material can be stored on the top floor and the mixing with the vehicles should be done there or on an intermediate or half floor immediately beneath, while the mills are stationed on the floor next to the storage and mixing floor, and the pastes may be fed directly into the hoppers of the grinding mills without further handling.

Of course, this can apply only to factories having a large output of staple goods, because it would not be very economical to clean large mixers and mills very frequently to permit changing from one color to another.

Whenever possible, when the output of the mills is to be used as the base for liquid paints, it should be chuted right into the liquid paint mixer, which should be so arranged, that when the product is ready to be filled into containers, such as barrels, kegs, kits or cans,

the liquid mixer can be raised to convenient height from the floor, and the containers filled without using intermediate filling cans, thus preventing waste.

If a floor still below this is at hand, the final handling, such as closing packages, labeling, marking and shipping can be done conveniently here, or if the filling has been done on the ground floor, then ample room should be provided for doing this work. In paint factories, where much of the output is for supplying jobbers and dealers, quite a large stock of colors in oil and ready mixed liquid paints must necessarily be kept on hand at certain seasons of the year and the storage space for these goods should be so located, as to make the least amount of handling and rehandling necessary.

One very important item of expense in paint factories is fire insurance, as insurance men consider this business as extra hazardous. For this reason, and in order to obtain as low a rate as possible and to save waste and labor in transportation, the vehicles, such as oils, turpentine, benzine and any other solvents, that may be used in sufficient quantity, should be stored, if possible, in metal tanks in fire proof sheds outside the factory and piped to the mixing floors into smaller storage tanks, in quantities sufficient only for a day's requirements. This can be accomplished by the use of compressed air, centrifugal pump or similar means. Wherever these liquids are brought to a factory in tank cars, the storage tanks should be placed low enough, that the material may be discharged into them from the tank car without the use of pressure. Another item of economy is the use of measuring pumps on the mixing floor, wherever practicable.

Many large concerns make their own barrels, tin cans and packing cases, but where cases are purchased in large quantities, such as car load lots, economy can be practised by using conveyors for unloading these as well as for large size tin cans.

We will not dwell on what style of packages, tin cans, etc., are best or most economical to use for shipping, as that will depend largely upon the pleasure of the trade, but in order to prevent errors in labeling, marking, etc., it is a matter or precaution to use a stamp on all containers, which plainly shows to the initiated by letters or figures, as the case may be, the contents of package. While this does not absolutely prevent errors at all times, it is the best system of marking yet devised. When storing away goods in cases, that are to be shipped later on, it is best to have them dated and so stored that the oldest stock is moved first. The same applies to tin cans stored in bins, the latter to be so arranged that the oldest stock must necessarily move first and the person in charge should see, that the help follow that rule. No one has any adequate idea what waste there is in a factory, when this rule is not followed as the trouble is mostly discovered only after the goods have been on the dealer's shelf for a long time and the disgruntled customer returns an opened tin that contains old fatty paint or color that has become hard. There cannot be too much system in this respect or care exercised, the help as a rule being indifferent to or ignorant of the trouble caused. A system, that is not followed up to the letter is worse than none at all. This applies also to the system of keeping records of formulas of mixings and grindings.

The formulas given to the men at the mixers or mills should be collected by the man in charge of the floor as soon as a batch has been made and any changes noted that it may have been necessary to make. This precaution does not necessarily imply a suspicion of the honesty of the help, but will prevent errors and permit a true record to be kept in the factory office of all transactions.

If anyone however has any idea that a correct tally can be made between the material used and the material produced, he makes a very serious mistake and he will find quite a leakage that cannot entirely be accounted for by evaporation during the milling or mixing process. The salary paid to the clerk or clerks necessary to superintend the weighing and measuring in a factory of some size would cost considerably more than any leakage that can be figured in the long run. When, as is often the case, illiterate labor has to be made use of, some intelligent person must needs be on the floor to look after the weighing and point out the material required. As a further means of identifying the materials, it would be well to follow the method of a very prominent paint manufacturer not many miles from New York City, who used to number his dry white material like this: "Lead No. 0", "Lead No. 1", "Lead No. 2", and so on; Dry white lead being "No. 0"; French zinc, "No. 1"; American zinc, "No. 2"; and barytes, No. 3; whiting, No. 4; while his liquids were designated as oil; raw linseed being "Oil No. 0"; boiled linseed, "Oil No. 1"; refined linseed, "Oil No. 2"; while color grinder's Japan was simply "black oil." The names for white pigments as

barytes, whiting, gypsum, clay, asbestine, talc, etc., do not mean anything to the kind of labor referred to. Other details will be found in the body of this volume under proper headings.

PART I.

WHITE PIGMENTS AND WHITE BASES.

CHAPTER II.

WHITE LEAD MIXING AND GRINDING.

We must preface this portion of our book with the remark that when we speak of white lead, we mean by that term the hydrated carbonate of lead, known to painters as keg lead, when ground in linseed oil for their use, but of late known to the general consumer as corroded white lead, in distinction from basic sulphate of lead or sublimed lead. The latter will be dealt with later on as we proceed.

This being a description of methods employed to manipulate the dry pigment for the use of the consumer, we shall refrain from a description of the various processes in use for manufacturing the dry white lead, only incidentally touching upon these for a better understanding of the characteristics, miscibility, etc.

Historical.—Going back thirty years, there were exactly thirty firms corroding white lead by the "Dutch" process, yet white lead was made in this country as early as 1807, but up to fifty years ago about three-quarters of all the white lead used was imported from abroad, mostly from England. And it is a fact well known to the veterans in the trade that the bulk of these importations was not pure white lead, although so branded, but more or less "stretched" with barytes. The corroders in this country, however, at an early date agreed not to sell any of their products under their name, except the strictly pure article, and if at this day any firm corroding white lead in oil sells or offers for sale

any brand of white lead in oil that is extended with any other material, it is not branded white lead, but is labeled with some fancy name or brand.

Examination of Dry White Lead.

Our first aim in producing a high grade of white lead in oil brings us to the physical examination of the dry pigment.

No matter by what process white lead is produced, it is necessary that it be tested for whiteness and fineness. If on rubbing it out in oil with a spatula it feels gritty, it may be due to being "horny," a term applied by white lead men to dry white lead that has been overdried on steam pans; in other words, has become crusty, which may also indicate that the pulp has not been thoroughly washed free from lead acetate. Dry white lead of this character, when mixed and ground in oil, does not make good white paint and lacks in opacity (body). If, on the other hand, the grit is due to the presence of uncorroded metallic (so-called blue) lead, it can be readily determined by rubbing out some of the dry lead with a spatula or muller on a white marble slab or with a pestle in a mortar, using turpentine instead of oil as the vehicle, when the metallic lead will show more or less by clinging to the white surface of the marble or mortar. When white lead has this defect it is unfit for grinding in oil for several reasons. In the first place it will coat the face of the millstones and fill the furrows thereof with a coating of metallic lead, thereby preventing fine grinding and greatly retarding the output of the mill, not to speak of the very inferior product that is unsafe to be used as the basis of ready

mixed paints for white as well as for tints. First class white lead, aside from the defects just mentioned, should when rubbed up in spirits of turpentine and allowed to dry on clear glass, be a neutral white, as a grayish cast would show the presence of metallic lead in fine division, even if the dry lead be free from grit. If inclined to the yellow cast, it would indicate the presence of massicot or litharge, while a pink cast would show the presence of red lead or orange mineral.

Foreign Metals in the Dry Lead.

When white lead is corroded from metallic (pig) lead that contains an appreciable percentage of copper, the presence of the latter in the dry white lead can be readily determined by a very simple test. A small portion of lead is rubbed up in bleached linseed or poppy seed oil until fine; that is, free of lumps, to a paste, and then reduced to liquid consistency with spirits of turpentine and a portion of this placed in a three-quarter inch by six inch test tube and set aside to settle. If copper is present the turpentine will show a more or less greenish color, otherwise it will be clear. Should the turpentine, however, show a discoloration similar to rust it indicates the presence of iron in the white lead.

Excess of Lead Acetate, and Test for Its Presence.

As dry white lead supplied by the corroders is never adulterated, it is not necessary for paint grinders or other consumers to go to the expense of having elaborate chemical tests made, but still there are a few that under certain conditions can hardly be dispensed with. One of these is to ascertain the presence of lead acetate in objectionable proportion. It may be done in a simple

way. Grind a small portion of the dry lead with distilled water to paste, throw it on a wetted filter and wash with freshly boiled distilled water. The clear filtered liquid must show nothing more than a slight cloudiness on the addition of a little dilute sulphuric acid. Another and more difficult test, requiring the services of an expert chemist, is to ascertain the proportion in white lead of lead carbonate and lead hydrate, as much depends upon the pigment having these constituents within the right limit. An excess of lead carbonate and consequent deficiency of lead hydrate means lack of spreading power and oil absorption, while on the other hand an excess of lead hydrate means deficiency of body (hiding power) due to too great absorption of oil. In either case the life of paint made from such white lead in oil is shorter by far than when the lead is normal in every way. This test is made by taking a weighed portion of the dry lead, having previously been dried at 212 degrees F., carefully roasting it in a current of dry air and the water evolved intercepted by means of a weighed calcium chloride absorption tube. Unless, however, this test is made accurately it is liable to lead to erroneous conclusions.

Theoretical Compositions of White Lead.

The theoretical constituents of normal Dutch process white lead are claimed to be two molecules of lead carbonate ($PbCO_3$) and one molecule of lead hydrate (PbH_2O_2), which would mean about 70 per cent, lead carbonate and 30 per cent. lead hydrate. The author, however, found in a series of extended tests, made in a practical way in conjunction with those made in the laboratory, that all other features being normal, i. e.,

fineness, purity and dryness of the material from a number of batches, the average producing best results after grinding in oil proved to be 72 per cent. lead carbonate and 28 per cent. lead hydrate. Batches showing 68 per cent. lead carbonate or under proved to be deficient in opacity and without tooth under the brush, while when 73 per cent. lead carbonate was exceeded oil absorption and spreading quality was lacking. Tests made with quick process lead on a similar plan and extended over a long period showed a decided difference, probably due to a difference in the structure of the particles of the pigment. Here it was ascertained that the extreme limit within which the constituents gave good results was not less than 75 per cent. nor more than 78 per cent. lead carbonate, and the best average 77 per cent. lead carbonate and 23 per cent. lead hydrate. The pigment referred to here as quick process white lead, however, is not to be confounded with the many later day processes of manufacture, such as, for instance, the precipitation or electrolytic methods. It is undoubtedly the best process for quick corrosion, differing only in one respect from the old Dutch process or stack method, that instead of the metal being cast in buckles and placed in earthen pots that are imbedded in tan-bark, the pig lead is melted, and while in this state is "blown" into fine particles by jets of high pressure superheaded steam, and the powder thus obtained placed in large wooden revolving cylinders into which a supply of acetic acid is introduced and the manipulation kept up by spraying the mass with water. In the meantime carbonic acid gas that is generated in a furnace by burning coke and washed and freed from sulphur is also passed into the cylinders through flues. The average time of corrosion by this process is twelve

days, as against sixty days by the stack method, and the product shows a lesser percentage of uncorroded lead. We do not intend to dwell upon the superiority or deficiencies of the various methods of white lead manufacture, having gone into this description of corrosion merely to illustrate how closely this quicker method resembles the other and yet how results differ. In the stack method, it may be said, that nature is given its sway to a great extent, while in the cylinder corrosion method artificial means are employed to hasten the result. In the former process very little attention is required after the pots have been set ,while in the latter constant vigilance is required in order to obtain a good and uniform product. It is claimed for the latter method that the process of corrosion can be inspected at any stage and at all times, day or night, and that this fact favors the output of a superior product.

While this should be true to a great extent, the fact is that white lead corroded by this method, no matter how uniform it may be turned out, is somewhat deficient in density and hiding power when compared with a sample of normal white lead corroded by the stack method. Nearly all, if not all, of the white lead made by any of the quick processes exhibited a tendency to lighter specific gravity than that made by the stack method, requiring a greater percentage of oil for grinding into the paste form, in many instances as high as 25 and even 50 per cent. more, and until this defect was overcome it was difficult to market the product, because the consumers found a sad deficiency of body (hiding power) in the product. These brands of white lead lacked what the painter calls "tooth" or "life," because when the paste lead was thinned to a consistency of what the

painter considered just right for application with the brush, it either flowed out like grease over the surface or was too "short."

The argument that the lead has the spreading capacity will not hold good with the painter, because it is the labor that counts for far more than the cost of the material, and if he can cover up a surface well enough with two coats of white lead paint he will not use three, and therefore will purchase the brand that gives him the result he looks for.

White Lead in Oil as Ground for the Trade.

There are two methods for grinding white lead in linseed oil for the market, the oldest being that still mostly followed, which is to mix the white lead in lump or powdered form, as it comes from drying pans, kilns or ovens, as the case may be, in suitable powerful mixers with linseed oil and chute it into the hoppers of large diameter stone mills, and when fine into coolers, and thence into various sized packages. The other method, which only came into general use twenty-five or thirty years ago, is the so-called pulp grinding process, in which the lead does not undergo any process of drying, but is placed in a suitable apparatus in the form of pulp, and therein agitated with a certain percentage of specially treated pure linseed oil until the lead and oil, which have great affinity for one another, unite and permit the clear water to rise to the top, which is then drawn off and the lead in oil passed over stone roller mills in order to eliminate all the remaining water possible. There is still a great difference of opinion as to which method of grinding, the dry or pulp ground gives best results as to the life of the paint made from either. Owing to the

prejudice against pulp ground lead, some of the corroders have given up the process, but there is no doubt that not a few are still using it. The writer, in making exposure tests of paint made from either of the two grindings of lead, all other things being found equal by laboratory examinations, found that the paint from pulp ground lead did not show any chalking tendency inside of three years, while that from the dry ground lead chalked badly in less than eighteen months' time. Yet the surface on which the paints were applied was of the same seasoned lumber, white pine weather boarding put up for the purpose and exposed to the south, both leads mixed with the oil and driers from same package and in similar proportions. The chemist reported both leads free from appreciable percentages of lead acetate, the moisture in the pulp ground lead as .65 per cent., and that in the dry ground lead as .29 per cent., while the percentages of oil were alike in both pastes. The reason that pulp ground lead has been given a black eye by some authorities and by consumers may be looked for in the fact that through ignorance or carelessness in manipulation or the use of improper oil, an emulsion between some of the water and the oil was formed, especially in the presence of appreciable quantities of lead acetate. In describing the process of pulp grinding further on we shall touch upon this and other deficiencies.

The Grinding of White Lead in Oil (Dry Method).

It is essential to success in grinding white lead to select linseed oil that if raw must be well settled, so as to be perfectly free of foots, and when refined or bleached is free from traces of acid or alkalies, while

when boiled oil is wanted as the vehicle, it must be of the old fire or kettle boiled process, in which borate of manganese is the drying medium, so as to keep the white lead from discoloration. When the white lead is to be used for exterior work, or when the manufacturer places one brand only on the market, the pigment should be mixed with pure raw linseed oil only and so ground to the proper consistency.

For inside use or for use in car and carriage painting, where pure white effects are required and turpentine is the principal thinner, the vehicle should be bleached or refined linseed oil only. Boiled linseed oil should be used in grinding white lead only when so specified. Raw oil produces a stringy lead, so termed by the painters; bleached or refined oil makes the lead break up readily and excellent for stippling purposes and for flatting, being shorter and of stiffer consistency. White lead ground in boiled oil is specified only for admixture with red lead for use on ironwork and for mixing with varnishes that do not take kindly to raw or refined oil, but the practice has been pretty well abandoned.

The lead mixing and grinding rooms should be kept at a normal temperature during the cold season, and white lead in oil should not be mixed, ground or stored in rooms where the temperature is less than 50 degrees F. at any time, 60 degrees F. being preferable. The reason for this caution is that white lead mixed, ground and stored at lower temperatures will to a certain extent show a gritty appearance that will not disappear even when used in the warmer season, or when strained through the finest sieve. It is also of advantage to have the oil in which white lead is to be ground of a normal

temperature at not below 55 or 60 degrees F. during the winter season, so as to be limpid enough to mix and grind well. During the hot season, of course, the temperature of the oil is above the degrees named, according to where it is stored. But one of the principal precautions in white lead grinding is to avoid oil foots, and therefore it is essential to store the oil in tanks so arranged that it can be drawn without disturbing the sediment that collects in the bottom of storage tanks. By having the supply pipes above the bottoms of tanks and outlets arranged in the bottoms the sediments or foots can be drawn off from time to time, thus avoiding the source of many complaints that often are thought to be unfounded because not traced to their source. Dry white lead mixes best with oil when it has been made what is termed bone dry in the usual manner on steam jacketed drying pans of copper, or when filter pressed and then placed on wooden trays in drying ovens or kilns, and is then permitted to cool down and absorb the natural moisture of the air, which, however, should not exceed 25/100 of 1 per cent. When white lead in the so-called dry state exceeds one-half of 1 per cent. of moisture, it will not mix well with oil, heating up too much in the mixer and will not pass smoothly through the mill, and the output will be lessened to a great extent. Very much depends upon the care of the workmen in mixing the lead and oil, because by improper manipulation the material may be overheated in the mixer, and by choking up the mixers by overcharging the apparatus at times much power is wasted. White lead may be spoiled in mixing as well as in subsequent grinding through overheating. This may be deter-

mined by its having a decided yellow cast while hot, and though it will be a pure white again on cooling its opacity is destroyed.

Apparatus Required.

Having pointed out the necessity of care in the mixing of the material, we will now describe the apparatus used from time to time in the process. Where white lead grinding in oil is carried on a large scale, as is done by corroders, the building in which the operation is going on is usually so arranged that the dry lead is stored in hoppers or bins on the top floor, where it may be shoveled into the mixers that are let into the floor, and where supply tanks or pipes are at hand to furnish the necessary oil. These mixers are provided with the necessary shafts and blades to bring about the required consistency of the paste, and may be of more or less depth, reaching to a convenient height above the floor below, where stone mills with large hoppers are ready to receive the mixing that is passed from a gate that may be on the side or on bottom of the mixer. These mixers may be of any length, and in some instances have been constructed of a depth of ten or even twelve feet, but in the opinion of the writer are really impractical because they cannot be readily cleaned.

The most practical mixers are of a diameter of about 36 to 40 inches and not over 30 to 36 inches in depth, and they should be twin mixers, i. e., so arranged that the mill hopper can be fed from either of the two. This will give ample time to mix lead and oil in one mixer, while the material is discharged from the other, and there is no occasion to unduly hasten the mixing, for it goes without saying that thorough mixing assists the

process of grinding to a great extent, as otherwise the mill is compelled to do one-half of the work that should be done by the mixer. The favorite mills for white lead grinding have always been stone mills of 36 inches diameter, although in some cases the diameter preferred was 42 inches, the stones being of the French buhr type, because it was the belief that these did not only the best and finest grinding, but also imparted a polish to the finished product. While these buhr stones last a lifetime in lead grinding, it is a fallacy to think that they do better work than the so-called esopus stones, and it has been proved that the mills provided with the latter show a much larger output on all pigments of soft texture than the buhr stones. The principal advantage, after all, in milling white lead is the arrangement of the speed of the mills to correspond to the diameter of the mill stones or grinding surface and the proper dress of the stones, as well as the diameter of the eye of hopper, which really controls the feed. This should not be smaller than 10 inches for lead in oil of stout consistency, yet for a long time 5 or 6 inches diameter was thought to be the proper opening for the hopper of a 30 or 36 inch mill.

The speed of a 36-inch white lead mill should not exceed twenty-six revolutions per minute, otherwise the product will be overheated, as it will be at any rate, if the attendant is not careful to watch it. The idea of paint grinders always has been that unless the mill stones become hot there can be no fine grinding, and some have tried to help it along by heating the oil in cold weather, which is also a fallacy and liable to lead to erroneous conclusions. A stone mill soon becomes hot when tightened up well or set close, and therefore it

behooves the miller to take off a turn or two as the heating makes itself apparent. Unless he attends to this he is liable to ruin the mill stones as well as his product. When white lead in oil as it comes from the mill indicates a temperature of over 160° F., it is not a good product, as before stated, in point of covering power. This is why some white lead manufacturers have abandoned the use of twin mills and substituted chasers and roller mills.

This apparatus is best arranged with the chaser located so as to discharge the lead and oil after being well condensed into a strong mixer that is set into the floor with its body directly over a roller mill with granite stone rolls, the outlet or gate of mixer discharging on the center of the back roller. The idea of this style of white lead grinding is to crush the dry lead by the heavy weight roller in the bed of the chaser, adding as much oil as is required to produce a stiff paste, not unlike heavy putty in consistency, which imparts increased density to the product, but in order to overcome any inclination of the material to be gummy, it is run into the intermediate mixer and more oil is added to form a good medium paste. When the mixing is finished, i. e., when lead and oil are one uniform mass, the gate of mixer is opened, the rollers started and the paste lead given its polish by the rubbing and grinding of the rollers. As the lead in oil ground by this process does not become overheated, as is often the case on stone mills, it may be put directly in the packages required for commercial purposes. In some factories steel rollers have been preferred over the stone rollers, but the writer prefers the latter as least liable to discolor white pigments. If the dry white lead is soft and free from horny

particles, the chaser, mixer and roller process of milling will produce the best stiff lead for flat work, because the percentage of oil required is less on account of the condensing action of the chaser, and the consumer does not have the trouble of "drawing" the oil for flat work in jobs of decorating. When from 9 to 9½ pounds of oil is required for 90½ to 91 pounds of dry lead for each 100 pounds of the paste in stone mill grinding, 8 to 8½ pounds of oil for 91½ to 92 pounds of dry lead will produce a paste of similar consistency when using the chaser, mixer and roller mill. The power cost will be a little more, but the lesser cost for labor per ton will even this up.

As noted above, in grinding on stone mills the lead in oil is discharged rather hot, especially during the warm season, and it cannot be placed directly into commercial packages without the risk of forming a lump in center of container on cooling, or a crust on the side of the package; in short, the lead should be cooled to a normal temperature, which is best accomplished by a mechanical stirring device, a so-called cooler that is running at same speed as the mill and is in the shape of a shallow mixer, with mixer blade, from which the lead may be put up in containers same as from the roller mills. Years ago the mills were set fairly high above the milling floor and each set of mills was provided with a water-cooled turntable in front on which the lead in oil dropped from the mill scraper and was then scraped off in turn by a scraper attached to the table. This worked very well during cool seasons, but was of little or no use during the heated term.

Endless canvas belts have also been in favor in many white lead factories on which the heated product was dropped from the mills, carrying it a certain distance

away, so as to cool down and be removed by scrapers. The drawback to this system is that unless properly looked after there is too much waste, and the risk of mixing particles of dried up skin or crust into the commercial containers. Still another method, although rather primitive, for cooling the heated lead in oil, was to have large wooden tanks of great strength holding anywhere from two to three tons set on the ground floor in close proximity to the mills, into which a portion of cold water had been placed and the finished lead carried to these tanks in piggins or small tubs holding about 75 pounds each and dropped into the water. When such tank was nearly filled the top of the lead was leveled off by means of trowels and more water put on if required. This was done to keep the material from forming a skin on top and was a rather handy feature, as the lead could be kept in bulk for weeks or months, thus preparing ahead for the busy season, avoiding the necessity of keeping a large quantity in small kegs and pails, enabling the packers to ship non-leaking wooden packages. Of course, since the advent of the steel packages the risk of leakage is done away with, but not the skinning or crusting over by long standing. When the lead so stored is to be filled into packages for the trade, the water is carefully taken off from the top of tank and the lead in oil scooped up with strong iron ladles into whatever sized packages are wanted. There was a time when the practice of throwing the freshly ground lead into water had to be abandoned, because it was discovered that sometimes the lead stiffened up to such an extent that it was necessary to remix and grind it over again before shipping to the trade. This happened invariably when one of the storage tanks was filled too rapidly. The remedy adopted was to first

cool the lead by not placing more than one-third of its capacity of lead in any one tank twice daily, and when filled using raw linseed oil on leveling off the top in place of water. Some twenty years since a well-known firm of corroders conceived the idea of storing immense quantities of white lead in bulk, dry and in oil, and constructed a massive building of four stories with a basement. The basement was intended for the storage of commercial packages of lead in oil in wood, because this basement was of low temperature during the heated term. The first floor was for filling, packing and shipping, the second floor had a dozen large cylindrical steel tanks with funnel-shaped bottom, set in on a level extending to within four feet of the first floor, whence the lead in oil from each tank by means of a sliding gate and lever attachment could be filled by gravity into any package no matter of what size.

These storage tanks, each of which had a capacity of thirty-five short tons, and whose diameter at the top was 8½ feet, were filled by means of iron trucks on wheels of a capacity of one and a quarter tons that were brought from the mills, the product already cooled and discharged by means of a sliding gate. The extra cost of this work for labor was overcome by the economy in labor in filling the commercial packages by gravity, not considering the great advantage of being ready at all times to furnish very large tonnages of the product, without overcrowding the mills. The third floor was devoted to the storage of dry white lead in bulk, of which it held at one certain time nearly 300 short tons. This may at first glance appear like an unwise accumulation of stock, but it turned out to good advantage for several reasons, chief of which was a long protracted

shutdown in corrosion, the other that it confirmed what the late V. B. Grinnell, who had investigated the practical side of white lead corrosion and grinding for several years from the painters' standpoint, asserted in some of his writings, namely, that the belief that white lead in oil should be well aged was erroneous, but that the storing and ageing of dry lead was a great benefit to the quality. The writer has found that lead stored in the dry state for a month mixes and grinds more freely—ripens, as it were—and appears to be endowed with better body or hiding power. The fourth floor of the building in question was devoted to the storage of empty lead containers, and every floor had its heating arrangement by dry hot air flues.

Of course, the paint and color grinder who does not corrode his own white lead will not store very large quantities of dry lead to place on a floor or in a bin for exposure to normal atmosphere, but it will pay in the long run to purchase supplies well ahead, as even when in barrels or casks the dry lead will become more mellow and grind more freely when not too fresh, unless it be packed damp. The paint grinder who grinds paste paints consisting of part white lead and part zinc white, will do well to thoroughly examine his stock of lead for uniform dryness, because zinc white coming in contact with damp or moist white lead will give serious trouble when ground in oil in fairly stiff paste form, as lumping and partial hardness will be the inevitable result. We shall refer to this matter again when we consider the subject of grinding paste whites in general.

When grinding white lead in pale gold size or varnish for coach and car work, great care must be exercised in having the pigment as dry as is possible, and also that the vehicle is free from rosin or other soft resins.

The Pulp Lead Grinding Process.

This process was introduced by white lead corroders some thirty years ago, probably much earlier, but if so it was kept very quiet, as it did not become generally known to the trade until twenty-five years since. Even then the process was by no means new, as it had been carried on for years, but on a very small scale, and for a different purpose. When it was adopted on a large scale it was to save time and expense of drying the pulp lead after washing, and taking it all in all, aside from economical reasons, there is another phase to the question, which may be stated in short as follows:—When the hydrated carbonate of lead is mixed with linseed oil by agitation, thus separating the water from the pulp and uniting lead and oil without more heat than is generated by the friction incidental to the agitation, the resulting product will if all the water is thoroughly expelled, be free from any tendency to become stringy or gum up, as it is liable to do when run through overheated stone mills. The process resolves itself into something rather simple. It requires a building with several strong floors to conduct the process in, as the only economical way is to do it by gravity. The pulp washing and storage tanks must be on the top floor, whence the well washed pulp containing at least 33 per cent. of pigment is run into another large tank of wood that contains a stirring device, also of wood and steam coils of leaden pipes for the purpose of bringing the pulp to a temperature of as much as 120 degrees F., because at this temperature the agitation and separation of water is effected much more rapidly. On the floor below there is a weighing box on a stationary scale, which has near its top an overflow pipe and on its bot-

tom at one end several discharge outlets with valves that are directly over the agitators. These, which may be eight or ten feet deep and three feet or more in diameter, are made of heavy timber having heavy shafts running in a step in bottom of tank, while very strong mixer arms with heavy blades are fastened to the end of shaft in bottom and about three feet from the bottom there is a heavy cross arm that holds the shaft in place, and at the same time contains blades that extend toward the bottom of the tank. On this cross bar rests a brass sleeve that reaches to the top of the tank, but is loose and can be started by means of a clutch on the shaft by dropping a lever. This brass sleeve has a number of brass blades that are so arranged as to give the oil a downward course while the agitation is going on. The lead in oil, after water has been drawn, is discharged from the agitators by means of gates and passed into other mixers below, when all the water possible is drawn off and passed over stone rollers on the lowest floor, which squeeze out all the remaining water if proper care is exercised. So far the apparatus, which, of course, varies in construction according to the facilities of the buildings in which it is located. Now as to the manipulation itself. The well-washed pulp is run or pumped into the stirring tank and there allowed to settle to some extent, so that the excess of water may be run or siphoned off. This done, the mechanical stirrer is placed in action and the steam turned on for warming up the pulp lead. When sufficiently heated enough of it is discharged into the weighing box below to fill it up to the overflow pipe referred to above, and the weight ascertained. In order to make this fully understood, we will say that the weighing box is of wood, very strongly constructed, resting on a framework that again rests

on a large platform scale of say 5,000 pounds capacity, and the box is inclined toward the agitators, so that it may be flushed with clear water from a hose after being emptied of its charge of pulp lead. Assuming that the weighing box and frame work weighs 1,500 pounds, and that the box itself holds 1,000 pounds (120 gallons) of clear water when filled to the overflow, the dry weight of the lead contained in the pulp when the box is filled to the same point of overflow with pulp lead instead of water is figured on this equation:—Assuming that a batch of pulp lead in the box shows a gross weight of 3,500 pounds, we subtract the tare of frame work 1,500 pounds, leaving 2,000 pounds of pulp lead and water. From this we subtract 1,000 pounds for the capacity of the box when filled with water, leaving a balance of 1,000 pounds to be accounted for. Multiplying this by the figure 1.18, which has been ascertained to be the correct multiple, we have 1,180 pounds of dry lead in the 2,000 pounds of pulp. This having been ascertained, the pulp is run into one of the aforesaid agitators, and when the mixer is in motion a weighed portion of oil, amounting to not less than 9 per cent. of the weight of the dry lead ascertained as above is run into the agitator in a thin stream.

The higher the temperature of the pulp lead in the agitator or separator, the quicker will be the union of lead and oil and the separation of the water, always providing that the oil is of the right character. At certain times the separation of the water is effected in as short a time as twenty minutes from the time of putting the mixer in motion, while sometimes it will require over an hour or more. The most rapid action takes place when well refined linseed oil is being used and the

oil must be refined by the sulphuric acid process, well washed and clarified by settling before use. Raw linseed oil will not do the work no matter how well settled and clarified by age. It requires too much time to effect separation of the water, and the lead in oil so manipulated retains too great a percentage of the water. The process of separation, when properly attended to, is very interesting, because of the lightning-like rapidity of the clearing of the water and the uniting of the lead and oil. At first, as the stream of oil is run in the agitator on top of the pulp, it floats on top for a few minutes, then appears to form an emulsion with the water of the pulp, but all of a sudden the water clears, and on stopping the machine the lead in oil can be seen in the bottom of the mixer, so clear is the water, which is removed by means of a steam siphon and another small percentage of oil, say one-half of 1 per cent., of the calculated weight of dry lead added, at times even more, as may be necessary. With this addition of oil the lead in bottom of mixer is agitated some more, and then enough drawn into the mixers above the roller mills to relieve the agitator sufficiently to admit of running in another batch of pulp. In the mixers above the roller mills the mixing obtains the finishing touch, because here any moisture that may still be present comes to the top and can be removed. This additional manipulation also imparts compactness or density to the product, which is always more loose than dry ground lead in oil. The further running of the pulp ground lead over stone rollers aids in still further imparting density as well as pressing out moisture should such be still present. In some instances the lead has been run over a double set of stone rollers, or six of them in all. Some one may ask wherein is the economy of this process with all the

stages it has to go through, but any one that is or has been connected with the manufacture of white lead will readily see the benefit derived as against the process of drying the lead on steam jacketed copper pans or in drying rooms on wooden trays, the use of iron being out of the question because of discoloration from rust. Before the advent of the steel keg, wooden kegs and pails were glued on the inside to keep the oil from being absorbed by the staves, but most of the packages containing pulp ground lead in oil were not sized in order to permit the wood to absorb the moisture that had not been entirely expelled. As steel kegs and pails are now in general use, pulp ground lead must be manipulated much more carefully than it used to be years ago, as it is otherwise liable to discoloration.

CHAPTER III.

GRINDING SUBLIMED WHITE LEAD, ZINC LEAD AND ZINC WHITE.

Grinding Sublimed White Lead. (Basic Lead Sulphate.)

The grinding of this pigment does not practically differ from that of dry white lead in oil, but being of a harsher texture, should be ground on stone mills, preferably buhr stones, in order to get it down to proper fineness. When sublimed lead first came into the market, it had a tendency to harden while being mixed with oil, especially when becoming heated and afterward cooling before being run through the mill. Ten pounds of oil being required to 90 pounds of the pigment in those days to form a good medium paste in oil, the remedy adopted was to grind in a mixture of 90 per cent. raw linseed oil and 10 per cent. cottonseed oil. At that time sublimed white lead was composed of about 86 per cent. lead sulphate and 14 per cent. zinc oxide. At present as sold by the Picher Lead Company it is composed of 95 per cent. lead sulphate and 5 per cent. zinc oxide, and is more mellow than when marketed twenty-five years ago, and as a rule of better whiteness.

When ground for the trade in paste form (which is very seldom the case, however), and kept in bulk in quantity it must not be leveled off on top with water, because it will form a very thick crust on top that is difficult to mix in oil without regrinding. When ground in oil as a base for ready mixed paints, it is

usually combined with a portion of zinc oxide or hydrated lead carbonate, as well as such base pigments as blanc fixe or natural barytes, China clay, magnesium silicate (asbestine) or calcium carbonate (whiting). In this admixture it mixes and works much better than when ground in the pure state. There are a few points connected with this pigment to which we shall refer later on.

American Zinc Lead and Leaded Zincs.

Some twenty-five or thirty years ago a white pigment was offered to paint makers under the name of zinc lead, made from a lead and zinc ore found in Colorado and then known as Colorado zinc lead. It was a combination which the chemists found to consist of about 28 per cent. lead sulphate and 72 per cent. zinc oxide, rather coarse in structure and with decided yellowish cast. Many paint grinders experimented with this pigment and finally adopted it as a base for ready-mixed paints, while others made it the basis for a line of cheap tinted paste paints, sold as building paints and paints for agricultural implement makers, because of its comparatively low price, as compared with white lead and domestic zinc oxides. These pastes were, however, rarely sold pure, but the pigment was mixed with other inert mineral bases, such as calcium carbonate (whiting), calcium sulphate (gypsum), barium sulphate (barytes) or kaolin (China clay) or magnesium silicate (asbestine). A flood of these paste paints was let loose upon the market, especially by Western firms, under fanciful names or brands, and because of the low prices, their sale was enormous for a time. But the inevitable reaction set in later on, and, in spite of the improvement made in further developments of the

pigment, when it was made of a much purer white and of a composition consisting of about 45 to 48 per cent. lead sulphate and 52 per cent. zinc oxide, it has lost ground and is rarely heard of today.

Zinc Lead as a Pigment.

Like sublimed white lead, as it was first placed on the market, zinc lead was of a coarse, harsh texture, difficult to mix in oil and to grind fine and required a larger percentage of oil than a mixture of sublimed lead and domestic zinc oxide in similar chemical proportions, and when ground into a medium stiff paste in oil it was very apt to settle quickly, when thinned for use as a liquid paint and on standing about in that condition, exhibited a strong inclination to cake hard in the bottom of the paint pot. This was in a measure overcome when ground with a certain percentage of whiting, kaolin or asbestine, but was aggravated when gypsum or barytes was used. Another bad fault was its tendency to act on certain tinting colors, especially those not alkali resisting. Zinc lead, ground on roller mills, never made a fine paint and was rather hard on paint brushes. House paints made from a base of zinc lead did not make good primers for raw wood, and, used as finishing paints for exposed work, were very apt to crack and scale. Hence, the desire to correct these faults by combining it with more or less inert mineral pigments, as mentioned above. The average proportion of pigment and oil, when zinc lead came first on the market to produce a stiff paste was 86½ per cent. pigment and 13½ per cent. linseed oil, while later on, when the pigment consisted of nearly equal percentages of lead sulphate and zinc oxide, it was 88 per cent. and 12 per cent. respectively.

Leaded Zinc as a Pigment.

More recently a white pigment under this name has found its way into the paint market which, while it appears to have some of the features of zinc lead, is much bulkier, i. e., of lighter specific gravity. It is claimed for it that it consists of practically two-thirds zinc oxide in combination with one-third lead sulphate, and its selling price is considerably less than the cost of one-third white lead or sublimed lead and two-thirds of American zinc oxide. It is a Western (Missouri) product and it is well-known that all Western zinc ores contain more or less lead. When there is no objection to make a paint from part basic lead sulphate (sublimed lead) and zinc oxide the writer can see no reason why this pigment cannot be employed profitably. While not as smooth a mixing or grinding proposition as that of white lead and American zinc oxide, it has none of the refractory, harsh texture of zinc lead, nor its settling tendency. It mixes and grinds fairly well in oil and will make a medium stiff paste in the proportion of 87½ per cent. pigment and 12½ per cent. raw linseed oil.

Mixing and Grinding Zinc Whites.

When zinc oxides are to be ground in oil in paste form for the trade it is essential for good results that the dry zinc be stored in a dry place, because green or moist zinc oxide will neither mix well with oil nor grind smoothly, and when packed into containers in such condition does not keep or open up well when about to be used. Not only is it liable to open up with a crust on top, but also with lumps throughout the package. But when stored for too long a time dry zinc oxide is apt

to become more and more transparent, especially in open containers where the air has free access to the pigment. In such case the zinc oxide, or at least a portion of it, undergoes a chemical change, turning into zinc carbonate, and it is well known to experts that carbonate of zinc is transparent and lacks the opacity or hiding power of zinc oxide. In large establishments, where large quantities of zinc whites are ground in oil for the trade, the best apparatus for the purpose is composed of a chaser of good power, with a bed pan eight feet in diameter and a 5,000-pound roller with well-adjusted scraper and gate opening into a mixer, while the mixer discharges zinc and oil onto the stone rollers of a suitable roller mill, that must also be carefully adjusted to give the paste a good finish and appearance, no matter how stiffly the material may be mixed. When ground on a stone mill the resulting product is either too soft or becomes too ropey on cooling. The advantage of the apparatus referred to will be seen when it is considered that the chaser exercises a condensing action on the pigment, thus requiring a lesser percentage of oil to form the paste than would be necessary in an ordinary mixer and stone mill. The material exhibits greater opacity and, as a great portion of zinc in oil is wanted for interior flat work by decorators, or at least was in use for such purposes before the advent of the so-called modern flat wall finishes, the zinc so ground was more easily flatted without drawing the oil. To illustrate why this is possible we will say that when a package containing 300 pounds of dry zinc oxide is emptied into a chaser of the type referred to and the crushing wheel run over the pigment for, say, thirty minutes, and the zinc returned to the original package, the container will be little more than half filled with the

300 pounds taken from the chaser. In other words, the zinc has been condensed to a little more than one-half of its original bulk.

It is not necessary, however, nor would it be beneficial, to go to such extremes when grinding zinc in oil, because when done properly a portion of such density is imparted during the manipulation. The dry zinc is placed in the chaser with sufficient of the oil to lubricate the material while being mixed, and the weight of the crushing wheel gives enough of the condensing action to make it possible to get along with a smaller percentage of oil than is required in the ordinary process of grinding through a stone mill. Here an average of 18 per cent. of oil to 82 per cent. of pigment is required to have the paste go through the mill, while with chaser and roller mill the average will run 15 per cent. of oil to 85 per cent. pigment, all other features being equal. Furthermore, the daily production of the latter apparatus is at least double, and at times even threefold, as compared with that of a thirty-six-inch diameter stone mill. Of course, when the zinc oxide in oil is to serve as part of the base for ready-mixed paint it can be mixed in a rather soft form, and, in that case, run through a rather open stone mill and the output increased to a very large extent. Zinc white for the trade is usually ground in refined or bleached linseed oil and is in very little demand at present in poppyseed oil. Nor is raw linseed oil used for mixing with zinc for the trade unless so specified. Great care is necessary to have the oil as free as possible from moisture, as it tends to harden it in the package. Nor must zinc oxide be covered with water to keep the top of the material from forming a skin, because it acts as a hardener. When containers are not airtight,

as is the case with the so-called wire rim or wire top pails or kettles, a good method to keep zinc contained in them from forming a skin or crust on top is to cover the material over with disks of strong parchment paper of the diameter of pail before adjusting the lid. When zinc oxide is ground in oil for stock and stored in bulk in large containers, the top of the paste should be covered with a little of the oil, in which it has been ground, which can be removed and used again in future grindings, when the paste is to be canned or otherwise disposed of.

Combined Lead and Zinc Whites.

Paint grinders have had, some time or other, a puzzling experience in the grinding of combinations of pure lead and zinc paste paint, when the specification called for certain percentages of pigment and linseed oil, especially where raw oil was required. When the two pigments are mixed with the oil and then run through stone mills very close set in order to obtain good fineness the mills become heated much more rapidly than when either pigment is ground by itself. The only sure remedy to prevent lumps through the material after cooling is to keep it agitated after leaving the mill until it cools.

A sure way to prevent this lump formation is to place in a power mixer the proper percentage by weight of white lead in oil and zinc oxide in oil, both ground to proper fineness and give the material a thorough mixing, then discharging it direct into the containers required. This will cost a trifle more for labor, but if judiciously arranged, it will pay to do it rather than take the risk of having the material rejected.

Assuming that a certain white lead paint to be furnished in paste form is to be composed of the following: Sixty-six per cent. by weight of lead carbonate, 22 per cent. of zinc oxide and 12 per cent. of raw linseed oil, a mixing of 73 pounds of white lead in oil and 27 pounds of zinc, which, the latter having been ground at the rate of 22½ pounds oil to 77½ pounds dry zinc, will make a composition as per specifications, because there is usually a leeway of 1 per cent. on the oil permitted, either way, the usual proviso being, that paste must not contain less than 11 per cent. nor more than 13 per cent. by weight of well settled, pure, raw linseed oil. Whenever a chaser and roller mill is part of the equipment of a paint establishment, it is best policy to make use of it for combinations of lead and zinc, as well as for the grinding of the so-called combination whites. By long practice it has been determined that white paste paints of this combination, be they admixtures of lead or zinc oxide, sublimed lead or lithopone with barytes whiting, gypsum, clay or asbestine or any other inert white mineral are giving best results when manipulated on chaser and roller mills, instead of being forced through stone mills, where often they become overheated and when put up for the trade and kept in stores or warehouses for any length of time, prove on opening by the consumer to be badly settled and caked hard in bottom of containers. While the heavy roller in the chaser makes the material compact, its being put through the mixer and over the rollers loosens it up again without, however, taking away density, thus preventing gumming up in the package.

CHAPTER IV.

LITHOPONE WHITE.

Manufacture, Composition and Uses of the Pigment, Which Has in Recent Years Come Into General Use.

Lithopone or sulphide of zinc white has been in general use for twenty years or more in many industries where a white pigment of considerable body or hiding power is required that is not subject to change like lead carbonate and has not the brittle character of zinc oxide, besides being sold at a lower figure than either of these. Nevertheless it is still comparatively new to the general painting trade. Because of our tariff protection its manufacture in this country has made great progress. Yet in spite of this and the duty imposed on it, the imports are still in excess of the quantity manufactured here. A short history of its origin will no doubt prove of interest to our readers.

As early as sixty years ago, zinc sulphide was first thought of as a pigment for coloring India rubber and a patent for the process of its manufacture was issued in England. But it was not until twenty years later that zinc sulphide and its manufacture was seriously considered as a pigment for paint, and in 1874 a patent was issued for a process of manufacturing a white pigment, composed of zinc sulphide and barium sulphate, known as Charlton white, also as Orr's white enamel. This was followed in 1876 by a patent issued to a manufacturer named Griffith and the product, which was similar in character to Charlton white, was known as

Griffith's patent zinc white. In 1879 another patent for a more novel process was obtained by Griffith & Cawley, the product made under this process proving the best of the series placed upon the market up to that date. After that time many new processes were patented, all, however, tending to the same object, that of producing a white pigment, composed of zinc sulphide and barium carbonate, the results, however, in many cases ending with failure.

In the meantime, the chemical factories of Continental Europe, principally in Germany, Austria and Belgium, had taken hold of the novelty and under the collective name of lithopone or lithophone, by numerous processes, produced various grades of the pigment, branding the respective qualities as red seal, green seal, yellow seal, blue seal, etc., or selling them under some fancy name. Of this we shall speak later on. The crusade against the use of white lead in the various countries of Continental Europe, assisted the manufacturers, to a very great extent, in marketing their products, not only to industrial concerns, as has been the case in this country, until recently, but to the general painting trade. Up to 1889 the imports into this country were comparatively small. At that time one of the largest concerns manufacturing oilcloth and linoleum in the State of New Jersey began to import and use Charlton white. Shortly after that other oilcloth manufacturers followed suit, replacing zinc white with lithopone in the making of white tablecloth, etc., and later on abandoning the use of white lead in floor cloth and linoleum. This gave an impetus to several chemical concerns, that erected plants and began to manufacture the pigment. Competition among the manu-

facturers and the activity of the importers induced other industries to experiment with lithopone, and the shade cloth makers, who formerly used white lead chiefly, are now among the largest consumers. Makers of India rubber goods, implement makers and paint manufacturers are also consumers of great quantities, and the demand is very much on the increase, as the nature of the pigment is becoming better understood and its defects brought under control. Large quantities find their way into floor paints, machinery paints, implement paints and enamel paints, while the flat wall paints that have of late come into such extensive use owe their existence to the use of lithopone in their makeup.

Having thus described the origin and uses of the pigment, we now come to the question, what is lithopone? It is, in short, a chemical compound usually consisting of 30.5 per cent. zinc sulphide, 1.5 per cent. zinc oxide and 68 per cent. barium sulphate, but these proportions vary slightly in the different makes. Lithopone of this composition is sold as the highest grade, either as red seal or green seal, as it best suits the idea of the manufacturer. Many manufacturers, especially in Europe, sell and also export other brands under other seals, containing 24, 20, 18 and as little as 12 per cent. of zinc sulphide with very small percentages of zinc oxide, the balance being usually barium sulphate, but sometimes certain portions of China clay or gypsum (calcium sulphate) or whiting (calcium carbonate). Such brands are not a chemical compound, but mechanical mixtures of the chemically compounded lithopone and the admixtures referred to.

The brands of lithopone of the normal class, that of chemical manufacture, are marketed under such names as Ponolith, Beckton White, Jersey Lily White, Oleum White, Zinc Sulphide White, all of these being of domestic manufacture, and their composition is of the 30 per cent. zinc sulphide type. The German manufacturers and exporters of lithopone make use of fancy names for their brands and here are a few examples of these and the composition of the pigment:—

Porcelain White, 32 per cent. sulphide, 68 per cent. barium sulphate.

Durabo White, 24.5 per cent. zinc sulphide, 51 per cent. barium sulphate, 18 per cent. white clay, 5.5 per cent. infusorial earth.

Blanc de Comines, 27 per cent. zinc sulphide, 70.5 per cent. barium sulphate, 2.5 per cent. zinc carbonate.

Neutral White, 26 per cent. zinc sulphide, 66 per cent. barium sulphate, 5 per cent. infusorial earth, 3 per cent. whiting.

Edelweiss, 14.5 per cent. zinc sulphide, 84 per cent. barium sulphate, 1.5 per cent. carbonate of lime.

A great number of other brands with fancy names have gone out of the German market, because of some defects in the processes of manufacture. The English exporters, as a rule, offer three or four grades of lithopone, the lowest priced consisting of about 12 per cent. zinc sulphide, the best varying between 30 and 32 per cent. zinc sulphide. A white pigment of this composition containing more than 32 per cent. zinc sulphide does not work well in oil as a paint, although in the oilcloth and shade cloth industries an article containing

as high as 45 per cent. zinc sulphide has been used apparently with success. Carefully prepared lithopone, containing 30 to 32 per cent. sulphide of zinc with not over 1.5 per cent. zinc oxide, the balance being barium sulphate, is a white powder almost equal to the best grades of French process zinc oxide in whiteness and holds a medium position in specific gravity between white lead and zinc oxide. Its oil absorption is also fairly well in the middle between the two white pigments mentioned, lead carbonate requiring 9 per cent. of oil, zinc oxide on an average 17 per cent. and lithopone 13 per cent. to form a stiff paste. There is one advantage in the manipulation of lithopone in oil over both white lead and zinc oxide, it is more readily miscible than either of these, for some purposes requiring no mill grinding at all, simply thorough mixing with the oil. However, when lithopone has not been furnaced up to the required time, it will require a much greater percentage of oil for grinding and more thinners for spreading than the normal pigment. Pigment of that character is not well adapted for use in the manufacture of paints, as it lacks in body and color resisting properties and does not work well under the brush. In those industries, where the paint can be applied with machinery, as in shade cloth making, etc., it appears to be preferred, because of these very defects. As this sort of lithopone, ground in linseed oil in paste form, is thinned for application to the cloth with benzine only, and on account of its greater tendency to thicken, requires more of this comparatively cheap thinning medium, it is preferred by most of the manufacturers of machine painted shade cloth. Another point considered by them is that it does not require as much coloring matter to tint the white paste to the required standard depth

as would be the case if the lithopone were of the standard required for the making of paint or enamels. On the other hand, the lithopone preferred by the shade cloth trade would prove a failure in the manufacture of oil paints and much more so, when used as a pigment in the so-called enamel or varnish paints. Every paint manufacturer knows, or should know, that a pigment containing hygroscopic moisture does not work well with oil and driers in a paint and that with varnish especially it is very susceptible to livering on standing and to becoming puffed to such an extent as to make it unworkable under the brush. While the process of making lithopone is not very difficult or complicated, the success of obtaining a first class product depends to a great extent on the purity of the material used. Foreign substances in these are readily eliminated by careful manipulation, which, however, requires thorough knowledge and great care, as otherwise the result will be a failure, rendering a product of bad color and lack of covering power.

The materials used in a successful lithopone plant comprise barytes (crude), coal, zinc spelter, oil of vitriol, common salt, sal ammoniac, sodium phosphate, chlorate of potash, calcium chloride and caustic soda. Taking the average figures for several years, the percentages by weight of the consumption of each of these materials are as follows:—Crude barytes, 37.30 per cent.; bituminous coal, 26.59 per cent.; zinc spelter or scrap zinc, 9.63 per cent.; oil of vitriol, 22.05 per cent.; rock salt, 3.39 per cent.; sal ammoniac, .44 per cent.; sodium phosphate, .14 per cent.; chlorate of potash, .31 per cent.; calcium chloride .13 per cent.; caustic soda, .2 per cent. The average yield of lithopone from this material was

41 per cent of a normal grade, averaging 29.85 per cent. zinc sulphide, 1.63 per cent. zinc oxide and 68.52 per cent. barium sulphate.

The cost of manufacture naturally depends, in the first place, upon the location of the plant, a plentiful supply of clear water, as enormous quantities are required for the washing of the product; facilities for discharging the materials from railroad cars or boats, economical methods of handling the same, up-to-date crushers, mills and furnaces. Neither must the placing of levigating tanks, filter presses and drying ovens or kilns be lost sight of and it will be noted that it requires quite a plant full of apparatus to manufacture a paying quantity of lithopone. On the other hand, to run it most economically, is to have it going day and night, with double shifts of men and a shut down only when it becomes necessary to clean out and repair furnaces, etc., because every shutdown means quite an item of expense and a liability to produce inferior products until the plant is again in normal working order. Without going into minute details we may say, that for a plant with a capacity of ten tons every twenty-four hours a building, at a cost of about $25,000, fitted out with apparatus, costing as much more is required. The apparatus, including engine for running two reverberatory furnaces, a crusher for breaking the crude barytes, at least four large buhrstone mills, disintegrator, elevator, etc., and to furnish steam heat for drying rooms, consists of one or two reverberatory furnaces, a series of muffle furnaces, lined tanks for the zinc sulphate and barium sulphide solutions, thirty vats of about 1,500 gallons each capacity for washing the product, filtering presses, trays for handling the filtrate and drying chambers for same,

aside from numerous other tools and appliances. Where perfectly clear water cannot be had large tankage for filtering the water for levigating the product is absolutely needed.

The process of manufacture itself begins with the preparation of barium sulphide, usually termed black ash, which consists of breaking up the crude baryta rock in a crusher and running it through a buhr stone mill to a certain size, about like a small pea, screening it to avoid the dust, which is liable to clog the furnace, adding to every 100 pounds of this broken rock about twenty pounds of bituminous coal of small pea size, and about ten pounds of common salt to assist fusion. This mixture is placed in a reverberatory furnace, where it is heated to dull redness without admission of air. When the reaction has taken place the mass is placed in vats, digested and filtered. When the crude baryta rock contains, as is often the case, much clay, iron, etc., the pure barium sulphide must be leeched out and the foreign residue removed. When this black ash and its solution is being prepared, zinc spelter, zinc dross or scrap zinc or any available zinc salt is being dissolved in separate vats or tanks in sulphuric acid, forming a solution of zinc sulphate. The barium sulphide solution and the zinc sulphate solution should be of a concentration of 60 per cent. and at a temperature of 140 to 150 degrees Farenheit, when they are poured together, and the zinc solution should be poured at double the rate of the barium solution, in which case a precipitate is obtained that must be filtered and dried. It is self-evident that when zinc dross is used and in any case unless refined spelter is employed, the zinc solution must be treated with a compound that will eliminate all traces

of iron and other foreign materials. For this purpose chlorate of potash is added. The precipitate, after being filtered and dried, is now placed in muffle furnaces and heated at as high a temperature as 900 degrees Fahrenheit, when it is suddenly plunged into cold water. In calcining in the muffle furnace salammoniac to about 1 per cent. of the dry weight of the pigment is added to assist fusion. When the material is thus prepared it is carried to the buhr stone mills by means of centrifugal pumps and pipes or by other mechanical appliance and there ground in the pulp state to the standard degree of fineness, and then conveyed to the washing tanks, where it is washed over as often as it is necessary to eliminate all traces of impurities, free sulphur, iron, etc. This often requires as many as twelve to fifteen washings and sodium phosphate and caustic soda are added in very small portions to aid in the process. Calcium chloride is also added as a bleaching agent when the whiteness is defective. A minute quantity of ultramarine blue is also one of the ingredients to assist in eliminating too creamy a cast. When the test shows the pigment to be thoroughly washed, it is filter pressed, the cakes so formed are placed on wooden trays, the trays stacked up on suitable trucks and these put into drying rooms usually built of metal and heated by exhaust steam, which is augmented by jets of live steam. When the cakes of lithopone have dried, they are fed into the hopper of a disintegrator, which pulverizes the lumps into a powder of uniform fineness, and when this powder has been put up in barrels or casks of suitable size, the product is ready for the market.

In our percentages of materials required to produce lithopone of standard quality, we have included in the item of bituminous coal, not only the percentage for use

in the black ash, but also the coal required as fuel for the engine and the furnaces. It must be noted that of late crude petroleum has become quite a favorite for firing boilers, furnaces, etc., on account of the greater heat produced, but it is an open question whether or not its use is not detrimental to the life of a furnace and whether it is really more economical. The one great feature about the manufacture of lithopone, as compared with that of white lead is in its quick manufacture, for a working batch of lithopone can be turned out in three or four days, whereas even quick process white lead will require at least one month from the time the pig lead is unloaded, with one single exception, that of the so-called mild process of white lead. It stands to reason that the capital tied up in a lithopone plant is very much smaller than in the case of white lead manufacture. Another advantage of the process as against that of white lead making is that the health of the workmen is not as much in danger, though by no means pleasant, on account of the vapors and the heat. The cost of manufacture, exclusive of the capital invested, but including repairs to apparatus, superintendence and labor should not exceed $10 per ton (2,000 pounds), while the cost of material, packages, etc., necessarily varies with the condition of the market.

As stated in the beginning of this chapter, the white pigment known under the collective term lithopone white, is becoming more and more appreciated, not only in the special industries referred to, but also by paint manufacturers and painters. That it required so long a time to bring this about was due to the many failures when it was being used for painting exterior surfaces without a thorough knowledge of its characteristics.

That it should not be employed in place of zinc oxide in admixture with white lead (lead carbonate) and that driers with lead compounds should not be used when being mixed for spreading was well understood by chemists and most all paint manufacturers, but to the general consumer this information was a sealed book. Many of the so-called combination leads or combination whites had this zinc sulphide white as their base, because of its comparatively lesser cost and greater hiding power as against zinc oxide, and wherever discoloration or blackening of white surfaces resulted on exterior, where such combination whites were used, misleading explanations were usually made. This is now becoming better understood and paint manufacturers will confine the use of lithopone to colored paints for exteriors and so far as clear white is concerned to interior painting material. The tendency of lithopone to become gray when exposed to the direct rays of the sun has caused many a sleepless night to manufacturing chemists engaged in the production of lithopone and, while the subject is becoming better understood from year to year, and while many claim that they have discovered the cause and a remedy for the trouble, it crops out every once in a while unexpectedly with the very material for which a freedom from the effects of sunlight is claimed. When lithopone is mixed with water to a paste and applied to a strip of glass or other surface and immediately exposed to direct sunlight, the white assumes as the water evaporates a gray color, sometimes it becomes nearly black. When the strip is removed to a dark place the material becomes nearly if not quite white again. This property of absorbing light and giving it out again is also noticed when lithopone is ground in and thinned with linseed oil or varnish in neither of which any lead driers have

been used. When such white paint is applied on an exposed surface where the direct rays of the sun strike it before it has had an opportunity to dry thoroughly hard it will turn gray readily and, while it sometimes will regain its natural whiteness, such is not always the case. The reason for this has never been fully explained, but the writer has tried out numerous samples of imported and domestic lithopone, all being of approximately similar composition in the percentages of zinc sulphide, zinc oxide and barium sulphate. Every sample was mixed with the same vehicle, damar varnish from the same package in like proportions and applied side by side on a strip of wood, previously coated with zinc oxide paint and exposed at the same time to the south during the day. No remarkable change occurred until next morning, after the sun had been out for an hour, when every one of the samples had become discolored to a greater or less extent, two of the ten samples being nearly black, six having assumed the gray of agateware, while the other two showed a very light lead color tint. On examination it was found that none of the samples were dry, all showing the same decided tack. There had been a slight precipitation of dew during the night, which may account for the result, as it is a fact, that the presence of moisture in or on lithopone paint will aid in its discoloration by sunlight. The singular phenomenon in this test was, that after two days and nights, when the damar varnish had dried hard, all but the two darkest of the samples had regained their whiteness, while these two had assumed a dark cream tint. Whether the acidity of the varnish assisted in the discoloration of the samples the writer does not care to say, but he is quite certain that lithopone, when mixed with gloss oil, a solution of ordinary pine rosin and

petroleum naptha, and applied to an exposed surface, as on the head of a barrel, standing in sunlight, will turn a dark gray in a few minutes without the presence of moisture. Still, that moisture will have a disastrous effect on paint made with lithopone when exposed has been proved by the writer, who tested out paints with lithopone as the base, thinned with linseed oil and manganese drier, to which various percentages of a watery emulsion was added. Even though the paints were tinted, the results were astonishing, the greatest change showing in the tests made with the paint having the greatest percentage of emulsion.

There are many engaged in the manufacture of lithopone here and abroad who claim that they have perfected their processes so as to overcome all the objections to its use on exteriors and even have obtained patents to protect their inventions, but it is wise to be skeptical and make use of this wonderful pigment where it is known to be safe. The results shown by the panels painted with lithopone on the Atlantic City test fence on which a very high grade of lithopone was used, seem to prove that so far lithopone, because of its lack of durability, not to speak of discoloration (which was not seriously considered) is not to be considered as a good exterior paint, at least not, when thinned in the same manner as lead and zinc paint. Summing up its advantages and prospects, we may say, that it has come to stay and that a great future is before it, if not in the general line of exterior painting and decorating, it will be for interior work and in industrial consumption, which will increase from year to year as the country grows still more and more. As stated before, it has within the last few years, made great strides in the

manufacture of interior flat wall paint, where it is more sanitary than white lead paint, flatting far better than zinc white paint, and being more durable than cold water paint, at the same time being moderate in cost. It has become indispensable with oilcloth and shade cloth makers, in the rubber making industry and to many paint manufacturers in the production of floor paints, ship paints and cheap grades of enamel.

And it is in this pigment that the much-abused mineral, barytes or barium sulphate, has found a place where it has rehabilitated itself as the very useful adjunct to paints, that it really is and always has been. Here is, where it does not serve simply as a make weight or extender, but as a helpmate.

Lithopone White as a Pigment.

Lithopone whites, showing by analysis less than 30 per cent. zinc sulphide, are inferior grades made by adding barytes and possibly other extenders, such as carbonate of lime, china clay or sulphate of lime in varying proportions. To find the contents of zinc sulphide, which imparts body and resisting power to color in the pigment, it is not always necessary to submit samples to analysis, but comparative value may be determined by physical test by comparing various samples with an adapted standard, making rubouts with color. The one showing most resisting power to color will be the one containing greatest percentage of zinc sulphide. Still the lithopone may have the normal percentage of zinc sulphide and yet be rather weak in resistance, and this is the case when the material has not been furnaced long enough, retaining some water of combination. When this is the case, it may be determined by the excessive

quantity of vehicle required in grinding and by the rather slimy feel under the brush when worked out as a paint. That sort of lithopone is unfit for use in paste whites, that are afterwards thinned with oil or varnish, nor is it fit as a base for the modern flat wall finishes, and it is really preferred only by shade makers for painting shade cloth, because of the greater volume of oil and volatile matter it carries and the smaller quantity of color required to produce tints. Lithopone is readily recognized from zinc oxide by its smaller bulk and when the powders are treated by wetting up with dilute hydro-chloric acid. In the case of lithopone, sulphuretted hydrogen is evolved immediately under slight effervescence, while zinc oxide remains dormant and emits no odor, excepting that of the acid. As is now well known, lithopone or any other compounds of zinc sulphide are sensitive to direct sunlight, and while some makers claim that they have been able to produce a sunproof article, practical men are still very skeptical on that point. The writer has found several samples that were actually sunproof, yet in one instance the second exposure trial was a disappointment, while in several other cases the price was prohibitive in comparison with zinc oxide. There is no question but that vast improvements have been made during the past ten years in making the material more stable. The paint made from lithopone is unaffected in its whiteness by sulphuretted hydrogen gas or sulphuric acid vapors, but must be kept free of lead or copper salts, as these will invariably discolor it. A quick test for its resistance to strong light or direct sunlight may be made by rubbing up each sample with white damar varnish in pestle and mortar and applying the several samples on a board previously grounded with zinc white, side by

side, and exposing the board to the direct rays of the sun, shading one-half of the strips of paint in the most convenient way, so that whatever discoloration takes place during the setting or drying process may be readily observed.

Mixing and Grinding Lithopone.

Lithopone is the most miscible of white pigments and can be readily ground fine on any good stone mill, one having esopus stones being best for the purpose. When ground in oil in large quantities, the chaser and roller mill apparatus is best and most productive, while for grinding bases for flat wall finishes, gloss whites, etc., the stone mill is preferable and for some of these the mills are best when water cooled. It is, for many purposes in certain industries, simply mixed to paste form without grinding in oil and then thinned down to the liquid form with such vehicles as serve the purpose. The paint grinder who supplies lithopone white of normal quality in the paste form will find that with the chaser apparatus 12 pounds of a good refined linseed oil to 88 pounds pigment will produce a good workable material, while on stone mills he will require 14 pounds and 86 pounds, respectively. It would be unwise for him to purchase one of the lower grade lithopones, such as blue seal, yellow seal or black seal that contain less zinc sulphide than the green seal or red seal. It must be noted here that some of the manufacturers on the other side of the Atlantic brand the normal lithopone red seal and others green seal, so that either of these may contain 30 per cent. zinc sulphide, while the other seals used may denote any percentage from 12 to 24 per cent. The paint grinder, when purchasing only the normal quality, does not require any of the other brands,

because in mixing he can readily add the quantity of barytes required to reduce the percentage of zinc sulphide, when he has an output for goods of that class. This will avoid carrying an assortment of the material and he will not pay for its manipulation and carriage of the goods.

A caution that will not be amiss, is to be very particular before mixing lithopone in oil, to see that it is dry, not necessarily bone dry, but so that it does not cling to the scoop or shovel, but leaves those tools fairly clean. The dry material, as is the case with zinc oxide, should be stored in a dry place, as moist lithopone does not mix well with oil and much less so with the grinding vehicles that are used in lithopone bases for flat wall finishes and inside gloss whites. Here, as in all other lines of paint making, constant care and supervision is the great need for obtaining good results.

When an apparatus has been used for grinding white lead it is natural that it should be most thoroughly scraped and cleaned before lithopone is to be mixed and ground on same. This applies also when the change is reversed. When it comes to a chemical analysis of the goods, even fractions of 1 per cent. may be found and lead to a rejection of the goods with the incident loss of money and reputation. In fact, when it becomes necessary to mix and grind more than one pigment on the same apparatus, it pays to be careful.

CHAPTER V.

GRINDING WHITE BASES AND PIGMENTS.

Grinding the White Bases for Liquid Paints.

The methods of doing this most economically depends upon the arrangement of the building in which the ready-mixed paints are made and canned or packed for the trade. Naturally, the best arrangement is to have a building three or four stories high, mixing the pigment with the oil on the top floor, in apparatus discharging directly into the hoppers of the mills on the floor below and chuting the ground base into liquid paint mixers on a floor below the milling or grinding room in order to do away with handling the material several times, which entails loss of time and loss by waste. This method is, however, not always feasible, unless in a factory where large quantities of standard paints are being made on certain formulas. Where paints are being manufactured on special formulas of diversified nature it is more convenient to have the various pigment bases ground and stored in convenient tanks separately, so that the required quantity from each can be drawn and placed into the liquid paint mixer and compounded with whatever other bases constitute the formula. Thus, one tank would contain lead carbonate in soft paste form, another basic lead sulphate, another French zinc, while others would contain American zinc, zinc lead, lithopone, whiting or some kind of inert material that would be mixed for either pure white or tinted with the required colors in oil and thinned to the consistency

suitable for application with the brush or for dipping purposes. In other paint factories again, the bases are conveyed in suitable trucks to the mixers, but no matter how disposed of, they are always ground rather soft, so as to mix readily and, in the case of liquid paints, it is immaterial what percentage of oil is being used in grinding the base, because it can be readily adjusted in the final manipulation so long as the exact proportion of pigment and oil in the base is known. When it comes to the bases for dipping paints or flat finishes it is different and more care is required, as an excess of oil will give trouble because in one case it will retard drying, in the other it will produce flashing. In grinding these bases for ready-mixed paints the mills best adapted are those with esopus stones, because the pigments used are not refractory and buhr stones do not take a good hold on soft material, as they polish too readily. There is a great advantage when such mills are provided with pans around the running stone, which keeps the soft material from slinging all over the frame and floor, thus preventing waste and untidiness about the mill room.

We might say right here that in the grinding of white lead and white paints generally the men operating mixers and mills should be closely supervised in order to observe strict attention to having their own persons, as well as the apparatus as clean as possible, allowing no accumulation of waste, and before shutting down for the night or holidays to scrape down chutes and sides of mixers, scrapers and rims of mills, so that crust may not form over night or during shutdown and find its way into the product when starting up again.

Grinding Bases for White Enamel Paints.

Varnish, as a rule, is a rather delicate material and requires a great deal of attention, especially when it is being employed as a vehicle for grinding pigments of one kind or another. And, as our so-called enamels or gloss whites would not have or hold the luster expected from them without being made with large portions of gum varnish, we must consider how the base for the various grades should be manipulated.

No matter whether the base to be prepared is to serve for air drying or baking enamel white, no manufacturer can meet with success in satisfying the trade unless he starts right from the very bottom by having his grinding room as dust free as possible and provided with heating apparatus, so that during the cold season the temperature can be kept at a normal figure, say, about 70 degrees F. The mixing room should be separate from the milling or grinding room and the former frequently dusted. When the base is ground in varnish or in a vehicle with a large portion of varnish it is best run through a water-cooled esopus stone mill until of the required fineness, while for bases with a vehicle of heavy-bodied oil a printing ink roller mill is best suited. Still, with skilful attention and care a good stone mill will serve the purpose in the latter case also. Overheating must be avoided in any case, more especially when varnish constitutes the vehicle. The older method of making interior white enamel, known as china gloss, was to grind French zinc white in white damar varnish, which, as is well known, was simply a solution of damar resin or gum damar in spirits of turpentine (at the rate of 120 pounds gum damar to twenty gallons turpentine). The resin was either

dissolved cold by churning it with turpentine in a revolving drum or the solution was made by melting the resin in a kettle at low heat and adding the turpentine, the latter method giving the best product because free of moisture, but slightly yellow from the melting of the resin. Seventy pounds French zinc, ground in thirty pounds (about four gallons) of white damar varnish made a good base for china gloss and was also sold in paste form as French zinc in damar. When used as base for china glossing it was simply further reduced to flowing consistency with more white damar varnish. Another base for white enamel, now practically obsolete, was known as impalpable white in damar, and consisted of forty-four parts white lead of best selection, thirty-three parts French zinc white and twenty-three parts white damar varnish. On account of its good body (covering power) it was a favorite with casket manufacturers and ornamental wood workers, also used it on enameled furniture. The great advance made in varnish manufacture during the past twenty years especially through the development with China wood oil, has had much to do with discouraging the use of damar varnish as a vehicle for white gloss paints. Unless these are made for a special purpose the use of white lead as a pigment base for enamel has been very generally abandoned and French process zinc white and the better grades of American process zinc have the call, while lithopone is gaining ground in the moderate-priced gloss whites. Here is where varnishes with small percentages of China wood oil find their chief use in white paint.

Varnishes with China wood oil, however, are not suited as a vehicle for grinding zinc whites, because a zinc base so ground invariably shows a tendency to

"pudding" up, and on thinning for use the thickening keeps on, producing a sort of jelly instead of a paint with body. Another varnish not suited for grinding zinc whites is one that is made with manila gum, which has a simular thickening tendency and invariably will give trouble. Where the base is required for quick air drying white enamel it is best to grind zinc white in damar varnish and depend upon a good white enamel varnish for the subsequent thinning, unless the varnish maker can guarantee a quick-drying grinding vehicle free from manila gum and China wood oil. When it comes to white enamel of great durability or for baking purposes, the zinc white can be ground in a special baking varnish or in a heavy-bodied linseed oil, similar to that used in grinding white printing inks.

In Holland, the home of enamel paint making, and in England and Germany the manufacturers prepare a special linseed oil of heavy consistency by boiling without the addition of drying mediums and blowing air through it during the boiling process (known here as blown oil) and permit this oil to age in tanks. German painters know this as standoel, the name being derived from its being allowed to stand undisturbed for long periods. The zinc white is mixed with and ground in this oil or an oil bodied to syruplike consistency by boiling in varnish kettles, known to us as bodied or oxidized linseed oil, such as may be prepared by any expert varnish maker. After grinding, the white enamel base is set away to ripen in well-covered containers for at least two weeks, sometimes much longer, before it is reduced with varnish or other diluents, but of this we will speak later on. The chief point is that the ripening of the paste is of great importance in the

final product, and it may be stated right here that much of the trouble found in the working of enamels is due to undue haste in thinning down the fresh-ground base, which is often still hot from the mills.

Grinding of Quick-Drying Whites.

A number of quick-drying whites are in demand by the carriage and car manufacturing trade, as well as in a few other industries. Foremost among these is flake white in japan. The term "in japan" is used, as a rule, to indicate its quick drying, merely as a short description. As japans are usually dark, mostly brown, it stands to reason that flake white, which is wanted for pure white jobs, cannot be ground in such a vehicle, hence color manufacturers will grind in a suitable vehicle of great paleness, generally a mixture of very pale hard gum varnish and turpentine, tempered with a small percentage of bleached linseed oil, according to the quickness of the varnish, which should be really in the nature of a rubbing varnish. The term flake white is often misconstrued, many in the trade believing it to be identical with zinc oxide, but it is not. Flake white is or should be same as Cremnitz white, a specially selected grade of lead carbonate deriving its name from the fact that, in the past, extra fine selections of white lead were sold in flakes, and when sold in cubes white lead was sold as Cremnitz white or Kremser white, deriving this name from the town of Krems, in Austria, where it was manufactured, pressed in cakes out of pulp lead and cut up into cube form, each of which was wrapped in blue paper separately and sold at a high price to artists that prepared their own colors in those

days. Thus quick-drying white lead, whether it be furnished the consumer under the brand or trade name of "Flake White" or "Cremnitz White" or "Silver White in Japan," is a fine selection of dry lead carbonate, ground in medium soft paste form on a clean water-cooled stone mill, requiring about twelve pounds of the above-mentioned vehicle to eighty-eight pounds of pigment. Aside from being used under pale rubbing and finishing varnishes as a pure or a creamy white, it makes a very good base for very delicate tints on vehicle work of any kind where zinc white would not be elastic enough to stand the vibration incidental to vehicles or the exposure to the elements, and where lead in oil is too slow in drying for the rapid work demanded these days. It also serves very well as ground work for ornamental jobs where quick drying is required and where the finish is done with zinc white in a similar quick-drying vehicle. This is commonly known as zinc white in japan or in varnish, but its trade name is Chinese white in japan. Here the vehicle used in grinding should be still paler, and because of the tendency of zinc oxide to scale and crack it should also be tempered with more bleached oil, unless a longer varnish is selected. The zinc oxide for Chinese white is, or at least should be, the best grade of French process and free from moisture. Twenty to twenty-two parts by weight of the vehicle to seventy-eight or eighty parts by weight of the pigment will produce a paste of good consistency. The grinding must be done through a water-cooled stone mill that is very well cleaned and in a dust-free room. The mills with porcelain grinding disks that have been recommended for the purpose may serve well enough to grind artists' tube whites in a small way, but are more of a toy in a large establishment.

Knifing in lead, glazing lead or draw putty, as the material is known to the carriage trade, is often called for by exacting painters, and there are several ways to prepare this. For general use a good formula is to mix and grind on water-cooled stone mill of at least twenty inches diameter sixty parts by weight of dry white lead, thirty parts by weight of pure white lead in oil, six parts by weight of good twelve-hour rubbing varnish and four parts by weight of coach or gold size japan, adding during the grinding about two parts pure turpentine. The result should be 100 pounds of finished material. Or if the material is to set more quickly, eighty-eight parts by weight of dry white lead, mixed with six parts each rubbing varnish and coach-grinding japan, may be mixed and ground as above, adding whatever portion of turpentine may be required to make it pass freely through the mill. White rough stuff is prepared in a similar manner, with the exception that, instead of all white lead, whiting or a mixture of whiting and pumice stone is used as pigment. One of the formulas is as follows:—Fifty-four parts by weight of dry lead, twenty-seven parts English Cliffstone Paris white, six parts rubbing varnish, three parts pale gold size japan, ten parts turpentine. Another formula producing a less unctuous product, but one that will sandpaper or rub more freely, is made by mixing twenty-eight parts by weight of white lead, twenty-eight parts powdered soapstone, twenty-eight parts flour of pumice, seven parts rubbing varnish, seven parts turpentine and two parts pale gold size japan. This will, when reduced with turpentine to brushing consistency, make a very good filling.

Grinding Whites for Artists' Tube Colors.

Among the standard whites for artists' use, and put up in collapsible tubes, there are offered to the trade white lead under the name Cremnitz white, flake white, silver white or Venetian white; zinc oxide under the name zinc white, Chinese white, snow white and permanent white. Blanc fixe (precipitated barium sulphate) is put up in tubes under the name of permanent white, while sometimes lithopone white parades under the same name, although it should have no place on the artist's palette.

In order to produce white lead in oil for artists' use only the purest in point of whiteness should be selected, and mixed with poppyseed oil that has been bleached by settling and age, although nut oil (from the kernel of the walnut) will also work well. The mixture should be ground to impalpable fineness and of a stiffness that will not permit the oil to separate from the pigment. It will require from nine to nine and one-half pounds of oil to ninety and one-half or ninety-one pounds of white lead and a well-balanced stone mill of utmost cleanness to accomplish this. The stones of the mill must be well dressed, so that the paste white is not munched into a gummy mass during the grinding process, and it is well to see that the pigment is free from moisture before mixing it with the oil. Should the paste come out of the mill too soft it is best to let it become cool and return it again to the mill hopper, after adding more dry lead, passing it once more through the mill. If for any reason the desired stiffness of the paste white cannot be obtained in this manner and the addition of a wax emulsion is undesirable, it is best to run stiff pulp ground lead through a stone mill of small diameter, and

in the resulting product the oil will not separate from the pigment. In such case the use of poppyseed or nut oil is impracticable.

When grinding Chinese or zinc white for putting up for artists' use in tubes only the very best French process zinc is selected, and whenever possible the dry zinc should be somewhat condensed in a chaser, so that it is more compact when being placed in the mixer with the poppyseed or nut oil, when, during the process of mixing and grinding it will loosen up somewhat and yet not separate from the oil after being put away in collapsible tubes. The average proportion of zinc and oil will be eighty-three parts by weight of the former to seventeen parts of the latter. The more mellow the texture of the zinc oxide the more readily and the smoother it will grind out.

As before stated, when zinc oxide in the dry state is exposed to the air for a long time it undergoes a chemical change, turning from zinc oxide into zinc carbonate, the latter pigment being practically transparent, and this fact has been made use of by some European manufacturers of artists' colors in placing this pigment ground in oil at the disposal of artists under the name of glazing white or transparent white. There are no statistics obtainable as to what extent this material has been employed.

Blanc fixe or permanent white or baryta white for artists' tubes is not made with natural barytes, but is the artificial pigment known to the trade as blanc fixe, usually made from a solution of barium chloride from which barium sulphate is precipitated by the addition of dilute sulphuric acid. Blanc fixe is distinguished

from the ordinary or natural barytes by its greater fineness, greater bulk and body and by its purer whiteness, and last, but not least, its far greater absorption of oil.

While the purest natural barytes may be ground into a paste with 8 to 9 per cent. of oil, i. e., ninety-one to ninety-two pounds of pigment to eight or nine pounds of oil (only inferior and off-colored grades require more oil), artificial barytes, or blanc fixe, requires anywhere from 16 to 20 per cent. of oil to from 80 to 84 per cent. of the pigment, according to its fineness of division.

Grinding White Pigments in Water.

Although the demand in this country for whites ground in water without size for fresco or distemper work is not large, no color grinder's price list or catalogue is complete unless the list of water colors contains flake white or white lead and Chinese white or zinc white. When the grinder is also a corroder of white lead or when a color-making establishment is connected with the factory where pulp white lead is being constantly used, the most simple way is to take the stiffer portion of such pulped lead and run it through a stone mill until enough of the excess of water has evaporated and the resulting paste is fine and of good consistency. Where this is not feasible, dry white lead is mixed with pure water, requiring about twenty-five pounds or three gallons of water to seventy-five pounds dry lead, resulting in a finished product containing about 80 per cent. white lead.

Dry zinc oxide, having great avidity for water, requires almost its own weight of water to form a good

mixture to put through the mill, and when finished to be put in glass jars for the trade it consists of about 65 per cent. by weight of pigment to 35 per cent. of water.

Zinc white ground in water to paste form has many uses in various industries and has been used in that form by calico printers after adding certain mordants. Furniture makers have made use of it for cheap work by adding it to glue size or with casein, thereby saving in the number of paint coats. Also used on white canvas shoes with the necessary binder.

CHAPTER VI.

EXTENDERS AND FILLERS AND THEIR USES.

The extenders, some of which are now also classed as reinforcing pigments, and which are mostly used in "letting down" white paste paints, as well as colors in oil, ready mixed paints, and are also useful in dipping paints, and special paint coatings are generally mixed and ground together with whatever white or colored pigments they are to be added to. But there are some exceptions to this rule, and under certain conditions or for certain reasons they are ground in oil or other vehicle in paste or semi-paste form to a certain degree of fineness and kept in that form to be used alone or added to other whites or to colors as occasion may require. We shall only describe those that are most commonly used, omitting the rare materials as being of little or no practical interest.

Those that are of real practical interest to the paint maker and color grinder comprise natural barytes and precipitated barytes or blanc fixe, carbonate of barium and magnesia, the various grades of whiting, gypsum, marble dust, china clay or kaolin, silex or silica, asbestine and starch.

Natural Barytes (Barium Sulphate).

This occurs in nature in a crystalline mass, known as heavy spar, and is mined same as iron ore, and is more or less contaminated with foreign material. When the crude article comes to the mill it is sorted and as much as

possible freed from the foreign matter, which is usually sand or clay, but sometimes it is colored with oxide of iron running through the lumps in veins. The lumps are broken into small pieces through a crusher, and formerly these pieces were ground to a coarse powder in an edge runner mill or chaser, and then mixed with water in the hopper of a buhr stone mill, which ground it fine. Some well-equipped barytes mills did not use a chaser, but had double sets of mills, grinding from one into the other, thus saving handling or conveying apparatus. In addition to this the material so ground to pulp was allowed to run into levigating tanks, where it was washed and floated. After settling the top layer was drawn off and dried, then pulverized and put up for the market as floated barytes. This refers, however, only to material which was white enough when the levigation had taken place. Of course, the heavy or coarser portion that settled to the bottom of the levigation tank was once more returned to the mill in order to bring it to the standard degree of fineness. When the material is "off color," due to presence of iron, it is necessary to bleach it. This is done by running the water-ground barytes into tanks lined inside with lead and fitted with steam coils of lead pipe to enable the operator to heat the pulp and water. When the water is near the boiling point sulphuric acid is added, which dissolves the iron without affecting the pigment. When a sample taken shows that the bleaching process is complete, the acidulated water is drawn off and the pigment washed with fresh water, until every trace of acid has disappeared. The pigment so treated is usually whiter than the material that did not require bleaching. Water floated barytes is without question the best form in every respect, while the many attempts

at air floating have not succeeded in producing its equal. Barytes is a very heavy pigment, its average specific gravity being 4.6, and a one-gallon can of the dry powder weighs anywhere from 15 to 18 pounds, according to its fineness. It is the most permanent white pigment known, being unaffected by sulphuretted hydrogen, acids and alkalies.

It does not combine with oil, and the mixture of barytes and oil is simply a mechanical one. When mixed and ground in a chaser a stiff paste may be made with 93 pounds of barytes and 7 pounds of linseed oil, while running the mixture through a stone mill 92 pounds of barytes and 8 pounds of oil will produce a fairly stout paste, providing the barytes is pure spar and not mixed with appreciable percentages of silica or aluminum silicate. One gallon of paste barytes in oil mixed stiff on the chaser will weigh 27 to 27½ pounds, while that run through the mill will not exceed 26 pounds to the gallon.

While barytes is or has been considered mainly as an adulterant or make-weight in paint, its function is now better understood, and so long as it does not parade in the guise of another higher priced pigment, there should be no objection to its use when not overdone. In the manufacture of commercial chrome greens it is practically indispensable.

Testing the Properties of Barytes.

The paint grinder or color maker will select the barytes he requires by assaying for fineness and whiteness (absence of color) principally. It was the custom with some barytes manufacturers to add minute

quantities of ultramarine blue to the pulp to disguise the yellow cast in some of their goods, but discriminating color makers objected to the blued article, because when using it with certain colors as an extender the addition proved anything but beneficial. And paint grinders who used barytes as extender for white pastes did not favor it for the reason that it was an easy matter for them to do the blueing if such was deemed advisable.

To test barytes for fineness, it is mixed with spirits of turpentine until the mixture is rather liquid and spread with a spatula upon a strip of glass, when it must not scratch the glass nor show any coarse particles, but should present a uniformly smooth film, which after the evaporation of the turpentine will also indicate the whiteness of the material. Of course, the test is best made in comparison with an adopted standard. The test for absence of color by placing small hillocks of dry barytes on a piece of white paper and pressing down the hillocks with paper laid on top is sometimes misleading and not conclusive enough for the paint grinder or color maker, and this also applies to the practice of rubbing out the dry powder on paper with a spatula.

Precipitated or Artificial Barytes. (Blanc Fixe).

Chemically this material does not differ from the natural product, both being barium sulphate $BaSO_4$ but blanc fixe, as the material is best known to the trade, is amorphous in texture, while the natural product is crystalline. Under the microscope this is best discovered, because no matter how well ground and how finely floated the natural product may be, it will reveal

its crystalline form under this test. The practical consumer, however, need not go to that trouble, as he can readily tell from the bulk or specific gravity of the two pigments which is the natural and which the artificial. Blanc fixe in comparison with ordinary barytes is more opaque, much finer to the touch and absorbs twice, even three times, the amount of color; hence it is a far better extender for white pigments than the natural barytes. The reason that it is not in more general use for this purpose is its higher cost, which is over twice that of the very finest floated natural product and its greater absorption of oil. A good grade of blanc fixe in powder will weigh from 10 to 12 pounds per gallon, and while natural barytes requires on an average of 8 pounds of oil to 92 pounds pigment for a medium stout paste, blanc fixe requires not less than 15 pounds of oil to 85 pounds of the dry powder, and when extra fine even as much as 18 pounds of oil to 82 pounds of pigment.

The greater oil absorption is not due to its lower specific gravity (average 4.16), but entirely to its fine division. Blanc fixe is produced by adding sulphuric acid to a solution of barium chloride when barium sulphate is precipitated as a fine white powder. The precipitate is well washed with warm water to remove all traces of acid, then if wanted in the dry form it is filtered, pressed, dried at low heat and pulverized. The bulk of the product, however, is after washing permitted to settle, the water drawn off, the pulpy mass thrown on filters until it consists of about 70 per cent. pigment and 30 per cent. water and sold in that form to the trade.

Barium Carbonate (Witherite).

Aside from heavy spar, which is barium sulphate, another form of barium occurs in nature, a carbonate of barium known as witherite. This is an earthy mineral, nearly white, that is insoluble in water, but dissolves in strong acids. It dissolves in hydrochloric acid with effervescence similar to any other carbonate. The solution when evaporated will crystallize and then forms a barium salt known as barium chloride, from which, as we have mentioned before, blanc fixe is precipitated by the addition of sulphuric acid. When witherite is calcined at intense heat it turns into barium oxide, similar to burnt lime or calcium oxide.

Barium carbonate or carbonate of barytes, as it is sometimes called, has a specific gravity of 4.1, and its chemical formula is $BaCo_3$, while its oil absorption and density are very similar to that of blanc fixe, but being a carbonate it is not unaffected by sulphur gases or acids like barytes or blanc fixe. It is therefore, not a safe pigment in paint, and one firm of paint manufacturers in the Middle West has been driven out of business by their indiscriminate use of it in all of their paint products. Some fifteen years ago they made great claims for their goods, and many of the most prominent hotels and large buildings, as well as a great many railway stations and equipments, were painted with the material, with the result that in a very short space of time the coatings of paint either changed color or disintegrated, according to local conditions. The next important of the pigments under consideration is

Carbonate of Lime (Calcium Carbonate)

the raw material in lump form being known as chalk, while when prepared for the use of the paint grinder or putty maker and the trade in general it is called by the collective term whiting, being classed according to grade as English cliffstone Paris white, American Paris white, gilders' whiting, Spanish whiting and commercial or common whiting. Marble dust also is calcium carbonate.

The Paris Whites.

Cliffstone Paris white is sold in both lump and pulverized form and is largely used in potteries for making the white glaze with zinc oxide. For admixture with fine grades of paint and in the manufacture of paste driers for plate printing inks, etc., it is preferred to any other grade, because when properly prepared it does not contain more than traces of grit. The method of its manufacture is similar to that of any other grade, with the exception that this and any other grade known as Paris white is levigated and floated. The crude lump chalk is broken up into small pieces in crushers, and the pieces of hard flint that occur in the chalk are removed as carefully as possible, as they play havoc with the mills, and the remainder of flinty substance not removed by picking is removed in the levigation and floating process, when the coarser particles settle to the bottom of the tanks and are known as tailings. The tailings are removed from the tank and disposed of before a new batch of the ground pulp is put in for levigation and floating, while the fine material is placed on steam drying pans in order to evaporate the water. In this process the chalk is ground with water, and the so-called bolted English cliffstone white, as well as the bolted

American Paris white, are really the pulverized lumps, as they come from the drying apparatus, put through a disintegrator or pulverizing apparatus. The average English cliffstone Paris white will show one-quarter of 1 per cent. of quartz or silica, while American Paris white will be found to contain from 1 to 2 per cent. of that substance, the balance being calcium carbonate in the form of chalk.

Common or commercial whiting is obtained by powdering the crude chalk without paying any attention to picking out the flinty material or to levigation and floating. This grade of whiting will show as much as from 8 to 12 per cent. of grit in the form of silica (sand). It is mostly used for making glaziers' putty.

Gilders' Bolted Whiting.

This grade is most called for. It derives its name from being used by picture frame makers for the ground of their moldings by mixing the dry whiting with glue size (and lately with a size made from casein), while decorators who prepare their own kalsomines also use it to a very great extent. This is simply the pulverized common whiting sifted or passed through bolting cloths to separate the coarse particles.

When Spanish whiting is called for at the present day gilders' whiting is usually sold under that term, while formerly it was similar to English cliffstone or American Paris white ground in water to a pulp, and this formed into cylindrical cones in molds and then dried.

Selecting and Testing Whiting.

The paint maker who uses large quantities of whiting will be discriminating in the selection of the material, and most likely find it to his advantage to carry several

grades in stock, as he would hardly care to use common whiting for anything but the making of glaziers' putty. Whiting, even the better grades, is mostly slightly alkaline, and therefore unfit to be used in admixture with Prussian or Chinese blue and other colors affected by alkalies. The litmus paper test is sufficient to determine the presence of lime. Sometimes by-products of chemical works are offered as whiting that are very alkaline, and although much better in whiteness than the whitings prepared from chalk direct, are unfit for use in paint. Whiting is sometimes colored with iron rust, and while this will not be harmful in many instances, it will not serve its purpose when mixed with a pigment of pure whiteness.

Whiting should be tested for fineness in the same manner as barytes, i. e., diluted with spirits of turpentine and spread on a strip of glass with a spatula, comparing its texture with a standard of known quality. Its absence of color can be determined by placing the standard whiting side by side with the samples in small hillocks, wetting these with spirits of turpentine or making rubouts in bleached oil. The material is so low in price as compared with other pigments that it would hardly be possible to find anything to use in admixture, excepting perhaps the by-products of chemical works referred to above.

The Value of Whiting in Certain Paints.

Whiting has been classed as an adulterant in paint, but this applies only where it is used in replacing a higher priced material without any tangible reason. As we shall see in the case of putty, there is no pigment that will take its place, and in any number of special

paints its presence is quite necessary. So, for instance, in some dipping paints that are sold in paste form to implement makers and others, where it would be a waste of money to use high priced colors without any extender or filling material. Most of the other extenders are too apt to settle and cake hard in the tanks, because of the volatile thinners used to bring the paints to the right consistency for dipping, while those of very low specific gravity are not well adapted to the purpose. In certain kinds of machinery paints, such as fillers, where the material is applied with the spatula or knifed in, a certain portion of whiting is beneficial. In fact, wherever paint is not exposed to sulphur gases a reasonable percentage of whiting is in place. In nearly every specification for paints issued by railroads, excepting in whites, an amount of not less than 2 or 3 and not over 5 per cent. of carbonate of lime (whiting) is called for, and government specifications permit the presence of whiting or carbonate of lime in all oxide of iron or earth paints to that extent. A certain percentage of whiting with red lead in oil prevents it from sagging or running, and grainers add whiting to their color in oil to keep it from flowing together after wiping out or combing.

Whiting does not work well when added to a pigment in oil that is to be thinned with varnish. It is very apt to show up granular. Whiting when thoroughly dry will average from 8 to 9 pounds per gallon in weight, according to fineness. Taking American Paris white as a basis, a paste of whiting and oil will consist of 82 pounds pigment and 18 pounds oil, weighing when ground about 16 pounds per gallon. In semi-paste form 75 pounds pigment and 25 pounds oil a gallon after grinding will weigh about 13 pounds. In liquid form

60 pounds dry whiting ground with 40 pounds of oil will weigh 11 pounds per gallon. Whiting mixes well with an emulsion of oil and water in a paint made from lead carbonate, but does not wear well if used for priming wood, because the water of the emulsion is absorbed by the wood, and there is not sufficient binder left in the paint, causing it to peel or scale.

Marble Dust.

Marble Dust, besides being used in cheap putty, has been largely employed in place of whiting in low-priced paste paint, because, aside from being lower in price than whiting, it absorbs less oil in grinding. A paste, that when made with Paris white will require 18 per cent. of oil for a fairly stout consistency, will require only 14 to 15 per cent. of oil when made with marble dust of good fineness. But marble dust, no matter how finely pulverized, will never be as amorphous in texture as whiting, and when used in liquid paint is apt to settle badly, causing hard sediment in bottom of container. Hence it is very seldom used in the preparation of ready-mixed paint. It has been found in very low-priced paste wood fillers, but cannot be recommended even here.

China Clay or Kaolin in Paint.

When we use the terms china clay or kaolin, we refer only to the white earthy pigments of silica and alumina, that are used in paints and colors. We pass by the species of earth known as pipe clay, potters' clay or fire clay, for which there is no use in paint making, because of their color and other special characteristics. While the general term for white clay is kaolin, this name is

used among our trade for the white clay mined in various parts of the United States, principally in Alabama and South Carolina, but also in some Northern localities. This will answer many purposes in the line of paint manufacture, but where a really soft and very white material of this character is required the imported article known as china clay, which is mined and prepared for export at Cornwall, England, is preferred. Pigments equaling this English china clay are also found in other countries, notably in Germany and France, but for commercial reasons hardly ever imported into this market. G. H. Hurst, in his work on "Painters' Colors, Oils and Varnishes," describes the origin, and also the manufacture of china clay, as it is being carried on at the clay works at Cornwall, so that it will be unnecessary to devote space to the subject here. All the white clays for use in paint must consist of silica and alumina with some combined water, otherwise they will not fulfill their function. The texture varies somewhat according to this composition, some being more unctuous than others. If silica were not present in the pigment it would have no tooth whatever and with oil produce a liverlike mixture. The china clay that by chemical analysis approaches closest to the following composition may be considered best for general use in paint; 47 per cent. silica, SiO_2; 39 per cent. alumina, AL_2O_3; 13 per cent. water, H_2O (allowing 1 per cent. for free moisture, magnesia, potash and iron). The color maker will, however, prefer the pigment that is entirely free of iron oxide. Domestic kaolin will vary somewhat from this analysis, generally consisting of more silica and showing appreciable fractions of one per cent. of iron oxide and lime. Still fairly large quantities are being used of the domestic article in many

special paints, where light weight per gallon is desirable. When china clay is imported it comes in large casks, two to the long ton, and the clay is in lump form, usually containing anywhere from 6 to 10 per cent. moisture that has to be driven off before it can be bolted for the use of the paint maker, hence the price of bolted China clay is so much in advance over the quotation of the importer. Enormous quantities of this clay are imported for industrial purposes, where it is used in the pulped form and in that case the amount of moisture cuts a figure only as to its weight. The clay absorbs some moisture in transit and on being stored in the open on wharves, hence the large percentage of water usually found.

Tests for and Use of China Clay or Kaolin.

The pigment, domestic or imported, is classed as hydrated silicate of alumina and should therefore be insoluble in water, alkali or dilute acid solutions. It is decomposed, however, by long boiling with strong sulphuric acid, forming alumina sulphate in solution and a precipitate of silica. The finer the grade the more greasy the feel between the fingers, while domestic kaolin always feels more rough, though it may be perfectly free from grit. To test for fineness, spread it mixed with turpentine on a strip of dry glass, treating a selected standard similarly. This test by permitting the turps to evaporate will also serve to test whiteness or absence of discoloration. Some china clays or kaolins are more opaque than others, and when the pigment is to be used as an extender for white paint, the most opaque should be selected, while when used for reducing color that with less opacity is best, as it does not absorb so much of the color, which is usually much higher in cost

than the clay. A simple test will determine this. Weigh out one drachm of each clay to be compared, also for each sample of clay 3 Troy grains of ultramarine blue and on a slab of marble or glass, mix the clay and blue with as many drops of oil as is necessary to make a rub-out, comparing all on a strip of glass, side by side, the clay that is colored most deeply by the blue being the least opaque, because it does not resist color as much as that which is more opaque. If this test is carried out accurately it will also show which of the clays requires most oil by noting the consistency of the rub-out.

China clay is not used to the extent it deserves in paint making, because of its great oil absorption and on account of its becoming rather transparent when ground in oil. It should not really be classed as an adulterant for the reason that it does not pay to use it as such, as there is more oil required to mix and grind it than is the case in grinding some of the pigments that are really adulterated. The average specific gravity of china clay or kaolin is 2.25, and a gallon of bolted or pulverized dry clay packed will not weigh over 6½ to 6¾ pounds. It requires 30 pounds, or nearly 4 gallons of linseed oil to mix 70 pounds dry china clay to a stiff paste, while 55 pounds of oil and 45 pounds of clay will be about the right consistency to be spread with a brush. Wherever whiting is barred out as an extender for heavy pigments for the reason that the presence of carbonate of lime makes the paint subject to disintegration from contact with sulphur gases, or that the alkalinity of whiting affects the color, as is the case with Chinese or Prussian blues, china clay or kaolin will be the best pigment to replace it. It is really a better suspender for heavy pigments than the ordinary grades of whiting

and only its higher cost, and the fact that it is so great an oil absorber, are against its more extended use. Bolted English china clay has also been offered to the trade under the name of English kalsomine for use in tints with colors that are not alkali proof, such as blues, greens and reds. Many liquid fillers for soft woods, or in fact, most of them contain china clay as the only pigment, while it has also been used in part as pigment for paste hardwood fillers along with some other white mineral substances or with starch. It is not so long since, that it was the custom to prepare the lower priced shade cloth by running muslin through a size prepared by cooking equal parts by weight of cheap starch and china clay in water to a paste, coloring same with aniline colors, and running the muslin so filled or painted over three heated cylindrical rollers of a calender, thus obtaining a fine and fairly well wearing finish on these low-priced shades.

Sulphate of Lime (Calcium Sulphate).

To this class belong gypsum (or terra alba, as it is often termed by its Latin name, meaning white earth), selenite and calcined plaster or, as it is more familiarly known, plaster of Paris. Gypsum is found in many parts of the globe, the cleanest and least off color variety coming from Nova Scotia, while abundant quantities are found in Michigan, Colorado, California and other States, as well as in Ontario and Quebec, Canada, although the mineral is somewhat discolored from iron oxide. Gypsum is the form preferred for use in paint making. It is chemically a hydrated calcium sulphate, having the formula $Ca\ SO_4,\ 2H_2O$, meaning that it

has two molecules of water in combination. Normal gypsum should consist of 46.5 per cent. sulphuric anhydride, SO_3, 32.5 per cent. calcium oxide, CaO, and 21 per cent. water, H_2O, or rather 79.04 per cent. sulphate of lime and 20.96 per cent. water of crystallization. When heated thoroughly to a temperature of a few degrees above 300 degrees F. gypsum loses its water of crystallization and is converted into an opaque white powder that when mixed with clear water has the property of setting into a hard mass, in which state we know it as calcined plaster or more popularly as plaster of Paris and known to chemistry as anhydrous sulphate of calcium with the formula $Ca\ SO_4$. However, gypsum, when heated in a furnace in admixture with sulphate of iron (copperas) may be dead burned so as to render it incapable of taking up or absorbing water again. The U. S. Navy Department in their specifications for Venetian red expressly refer to this feature and will not permit this red to contain sulphate of lime in any other form, while previous to the time of issuing these specifications the provision was that the presence of any sulphate of lime not fully hydrated was sufficient cause for rejection. The specifications issued by railroads whenever sulphate of lime is permitted in connection with oxide of iron paints still adhere to the rule of having it fully hydrated. The writer inclines to the belief, which is based on years of observation, that the U. S. Navy Department is on the safe side with their provision of having the calcium sulphate dead burned and probably more so than the railroad chemists who adhere to the previous rule of permitting no other than the fully hydrated form of calcium sulphate.

It seems like splitting hairs when authorities condemn the use of gypsum in paint for the sole reason that it

has been discovered that one part of gypsum is soluble in 500 parts of water.

Calcined Plaster (Plaster of Paris)

is not fitted or suited for a paint extender. A few decades since, the very brilliant business manager of a large paint factory, led on by the no less brilliant chief of the laboratory of a large corporation, both of the gentlemen referred to having since passed away, conceived the idea that anhydrous calcium sulphate (calcined plaster) first being mixed and ground on dry color mills to impalpable fineness with a certain percentage of nearly chemically pure red oxide of iron in place of using the hydrated calcium sulphate (gypsum) and then mixing and grinding the product in oil in the usual way would produce a Venetian red of greater brilliancy and body. Tests were made accordingly and carried on for about a month or so, when the manager was satisfied that he had made a great discovery. Orders were issued to substitute the plaster for gypsum in all Venetian reds so manufactured and inside of three months some 80 tons or more had been distributed to jobbers, dealers and consumers. All was going well until the spring season arrived, when some painters who had used the red color on brick fronts reported that after a driving rainstorm beating on the fresh paint it spotted white on drying. Several others who had used water on top of their pails containing the red to keep the paint from skimming over reported that the color had set hard in the pail for several inches from the top. After a thorough investigation the complaints were found justifiable and the reds were withdrawn from the market and remodeled by rehydrating the calcined

plaster contained therein which, although at no small cost, succeeded very well, as was proven by repeated trials. The parties in question had not taken into calculation that linseed oil takes up water and that, in consequence, the water, coming in contact with the paint after being spread, would cause the setting of the plaster.

Gypsum for Various Purposes.

Alabaster and Derbyshire or satin spar are extra fine grades of gypsum, not always pure white, and chiefly used for making ornaments. Satin spar especially comes in long, fibrous pieces. Selenite is another form of gypsum, large blocks of which may be found in the Rocky Mountains and the Indian Territory. The material is not hard, but transparent and will cleave like mica, but while mica will stand heat, selenite falls into a white powder under its influence. Is not a good form of gypsum for oil paint, but will serve the purpose of a white pigment for water paint when first heated and powdered.

Gypsum as Extender for Oil Paint.

Gypsum is tested for fineness in the usual way by rubbing up with turpentine and alone does not work well under the brush. It is readily colored by the oil it is ground or mixed in, no matter how colorless and transparent the pigment itself may be. When used with paint it is always considered as an extender or adulterant because of its comparatively low price. When used as extender for white lead or any other white paint it does not improve the hiding power of the paint, rather the reverse, but it will not discolor white, and in that connection it is useful. A further use for it is as

an extender for solid colors from whose brightness it does not deduct, but rather improves the tone. Take, for instance, a color like chemically pure Indian red or red oxide of iron. If ground in oil and thinned for use the color will look dull when painted alongside of the same red that has been extended or stretched with 50 or 60 per cent. of gypsum. Ultramarine blue extended with gypsum will look far more brilliant than the straight color, though of course it will not cover up so well. The one great drawback to an extended use of gypsum is, that when used in large percentages, especially with oxide of iron pigments, it is so very prone to settle and cake hard in bottom of containers, even when in stout paste form. When it can be used in connection with a portion of whiting or asbestine, or even with china clay, it will not be so bad on the settling, but it is at its worst when barytes or silex are present.

Testing Gypsum for Use in Paint.

Gypsum is tested for fineness in the usual way by rubbing up with turpentine in comparison with an approved sample and may be wet up with water in order to see that no error has been made as it has happened that partly calcined gypsum was shipped. A sample of the material should be dried at 212 degrees Fahrenheit, so that any excess of moisture be driven off without disturbing the water of crystalization. It has been the experience of the writer that, when gypsum had been allowed to remain too long on steam drying pans, although they were heated with exhaust steam only and the temperature hardly ever showing up higher than 150 degrees Fehrenheit, the material had lost several per cent. of its combined water; at least, it was so found by

the chemical laboratory test, that had two weeks previously found the goods normal in receipt. Gypsum has an average specific gravity of 2.33 and weighs 7 pounds per gallon packed dry, though some shipments that have absorbed moisture in transit will be found to weigh as much as 8 pounds. When gypsum has been well freed from moisture by drying, 80 pounds of pigment and 20 pounds of linseed oil will produce a medium stiff paste, weighing about 15 pounds per gallon, while 14 pounds pigment and 26 pounds of oil will make a semi-paste, weighing about 13 pounds per gallon and 63 pounds pigment and 37 pounds of oil would be a liquid transparent paint, weighing about 11½ pounds per gallon. Gypsum and china clay with or without the addition have been used some years ago as the pigment for paste wood filler, but we have good reasons to believe that at least the use of gypsum in this connection has been pretty generally abandoned.

Silica or Silex and Its Uses.

Silica or silex chemically considered is oxide of silicon and represented by the formula: SiO_2. When either is pure, they are insoluble in any other but hydroflouric acid, which readily dissolves them, especially on the addition of a trifle of sulphuric acid. Strong acids have no other action upon the pigment, except that of dissolving out such impurities as lime, oxide of iron, etc. Strong caustic solutions of potash or soda dissolve silica, when boiled, producing water glass, known as silicate of potash or silicate of soda according to the nature of the alkali used. Sand, flint, quartz are silicic anhydride and simply known as silica, but when obtained from flint it is known to paint men as silex, while

when derived from sand or quartz it is called silica. Under the microscope the latter shows a spherical form, while silex is more prismatic in the formation of its particles. This feature has been made use of in the manufacture of paste wood fillers for hard open pored wood, it being claimed that the structure of pure silex causes the particles to interlock and fill the pores or grains of wood far better than the round particles of silica. However this may be, so much is certain, that good silex in a filler will show up the natural beauty of the grain in wood far better than when the filler is made from silica or clay, the latter obscuring the effect somewhat by lack of transparency. On the other hand, when it comes to paint, the use of silica as a reinforcing extender is preferable to silex by far, for the reason that silex is much more refractory in grinding than silica and to purchase silex of the required fineness is prohibitive on account of cost. Very fine floated silica can be purchased at one-half, even at one-third of what silex of similar fineness would cost. The use of silica in paint has been condemned by many, simply because its function was not as well understood as it now is. There is no question but that silica adds porosity to paint, still if the paint is otherwise well balanced with opaque pigments, such as lead and zinc in a white and dense black, red or brown in a colored paint, the addition of a reasonable percentage of silica will prove far more beneficial than barytes, as it carries so much more oil, or than whiting or clay, because it is not so apt to peel or scale in the presence of moisture in the surface, while it is, like barytes, unaffected by sulphur gases. As the result of researches during the past decade it has been discovered that contrary to the older authorities, a moderate portion of silica in combination with solid

pigments, as lead, lampblack or carbon black, chrome greens, oxide of iron and even red lead will produce good non-abrasive, rust-preventative paint for iron or steel. Of course, the percentage of such addition should be figured on the opacity of the pigments it is to be combined with. For instance, 15 pounds of carbon black and 85 pounds of silica would not make as porous a paint as would 75 pounds of native red oxide and 25 pounds of silica.

Testing and Grinding Silica.

The quartz, sand or flint from which silex or silica is produced, differs according to location of the mines, but the best method is to heat the mineral at very high temperature and then plunge into cold water, which process makes it so brittle that it will break down more readily. For use in fillers or paint the floated article is the only proper one to use. To test the material for purity, weigh out, say, 10 grains of the suspected article, boil it in hydrochloric acid in a test tube, filter off the silica, wash to free it from the acid, dry and reweigh it. The loss or difference in weight represents the lime which is present in the sample. For fineness and color test as suggested for gypsum or barytes. Silica is a great absorber of oil in grinding, as it requires 30 to 32 pounds of oil for grinding 68 to 70 pounds of the fine floated silica to a medium paste. Its specific gravity averages 2.45 and its dry weight per gallon is about 7 pounds. When ground in oil and permitted to stand about it has the tendency to separate from the oil and set hard to a greater degree than gypsum, but when mixed and ground with pigments of low specific gravity, it holds pretty well in suspension, especially in a vehicle of good body.

One of the most popular paste wood fillers ever made in this country was composed of silex and was patented, but the patent has been extinct for many years. Starch was used as a means to hold the silex in suspension in the vehicle for a time, but later on additional patent claims described the suspensor as flour middlings. At the present day the use of starch or flour is very little in vogue, the manufacturers depending upon the vehicle for holding the silica or silex in suspension.

Magnesium Silicates.

Pumice stone, a volcanic substance, is a porous silicate of alumina and alkaline earth mineral. Asbestos is a fibrous silicate of magnesia and calcium, and this is why that extender, known as asbestine, that has during the last ten years come to the forefront in paint making, which is really a silicate of magnesia and slightly alkaline, but without the fibrous texture of asbestos or amianth has been given that name. Asbestine pulp, as a certain variety of the material mined at the foot of the Adirondack Mountains is known to the trade, although it is sold in the dry powdered form, belongs really to the soapstone or talc variety. But it is not as unctuous as either of those, has a harder texture, and is of whiter color than either soapstone or talc. Soapstone or talc is used for toilet powder and as a lubricant by shoemakers, also on dancing floors, in fillers, putties and cements, but not as a rule in paints. Asbestine pulp or asbestine in its various varieties has been used for many years by manufacturers of liquid paints, not so much as an adulterant, but rather to make the paint more buoyant in order to keep it from settling to any extent, as this pigment is of very low specific gravity

and a great oil absorber. This feature, however, depends on the location where it is mined, as there is a wide divergence in that respect. Its specific gravity varies between 2.3 and 2.7 and its oil absorption is between 30 and 36 per cent., or in other words, to make a paste in oil will require 70 pounds of the heavier asbestine to 30 pounds of oil or 64 of the lighter asbestine pulp to 36 pounds of oil. If manipulated in a chaser a stiff paste could be produced in either case with 10 to 15 per cent. less of oil.

Asbestine is used to some extent in making liquid fillers for soft wood, and with the proper kind of varnish the material holds far better in suspension than China clay, and certainly much better than silex or silica. Mixed with silicate of soda (water glass) it makes a very good fireproof coating. Asbestine is as inert as barytes or silica, and does not undergo a chemical combination with oil or water, but will be found sometimes more or less alkaline, and while it may be safely used as an extender with most any color, it has been found to be active on Prussian or Chinese blue when used in large percentages in admixture.

Magnesite or Magnesia.

Magnesia, when found in the natural state in the form of carbonate, $Mg\ CO_3$, is known as magnesite. It does resemble crude chalk in appearance, but is heavier in specific gravity than the latter, usually 3.06 on the average. It has been used by certain color makers in place of barytes as an extender for chrome green, and the product was known as magnesia green, but it has not come into general use as an extender for white or colored pigments in oil paints, but is ground

and levigated with water and offered on the market in pulp form as magnesia white for special trade. Calcined magnesia, however, is the form in which magnesia is used in some paints, not as an adulterant, but as a means of keeping heavy pigments in suspension. It is produced by burning the carbonate, when it changes the carbonate into magnesium oxide, MgO. Oxide of magnesium, called magnesia for short, is a white powder so light in gravity that a gallon of it does not weigh over twelve ounces, and when three pounds of it are mixed with eight pounds of oil it makes a very stiff mix, and a gallon of the paste when ground will not weigh over nine pounds. Only very small portions can be used in paint for suspending the heavier pigments, because of its taking away from their covering or hiding power. Where cost is not against it, it is being used in liquid fillers, either alone or with silica or clay. It can be made into a plastic mass with glue size or gum water and glycerine and formed to imitate various articles. Mixed with asbestine or soapstone and soluble glass in weak solution it serves as a fireproof cement.

There is still another form of magnesia, the sulphate. It occurs in nature as epsomite, and when artificially made we know it as epsom salt. In this form it has no value whatever in paint. When this is calcined, magnesium oxide is produced, but the economical way to produce the oxide of magnesia is to burn the carbonate.

Starch and Its Use in Fillers.

Starch cannot be considered as a pigment any more than flour. And while rye flour years ago was used in fillers and to a certain extent in roughstuff, the practice has been abandoned long since. It is well known that

starch is a vegetable principle contained in many plants, and especially abundant in the various grains such as wheat, rye, rice, corn, oats, etc., in seeds such as beans, acorns, peas, etc., and in tuberous roots as arrow roots and more especially in potatoes. But the starch of commerce, such as we have to deal with, is mainly from corn or wheat and from potatoes. It is a white opaque powder, and its specific gravity is very low—1.5. It is insoluble in alcohol, ether or cold water, but when united with boiling water and permitted to cool, the mixture forms a soft transparent paste. It can be made soluble by heating to the boiling point with glacial acetic acid or glycerine. By treating starch with dilute acids at 212 degrees F. it changes into that soluble substance we know as dextrine. When tested under a powerful microscope the various kinds of commercial starch may be distinguished from one another by the form of its grain or granules.

Potato starch grains resemble an oyster shell in form; wheat starch grains are mostly round or nearly round, while corn starch grains have a mark in the center similar to a cross or the letter Y. When starch is mixed with cold water it does not form a dough or become sticky like flour, but sets rather hard and is stirred with difficulty, especially when too much starch is used, twelve pounds of starch to one gallon of water being all that may be used for thorough saturation. It is hardly worth while to mention that to make a paste with starch, it is first saturated with cold water and then mixed with boiling water, four ounces of corn starch mixed with one-half pint cold water, and then briskly stirred and beaten with one-half gallon of boiling water makes a fine transparent paste.

Starch has been used in paste fillers for hardwood to keep the mineral pigments, such as silex, clay or gypsum, from setting hard in the package, but of course low priced corn starch is the favorite brand for the purpose. As much as 20 per cent. of the total weight of dry material has been added of corn starch. It is also the dry material in the most favored brands of floor crack fillers that are being successfully used in private residences.

PART II.

COLOR GRINDING IN ALL ITS BRANCHES.

INTRODUCTION.

This section will be devoted to the grinding of colored pigments in oil for the use of the painter and decorator, the artist, and for the various industries requiring such material, as well as for use in tinting ready-mixed paints, incidentally touching on printing and lithographing inks. At the same time the preparation and grinding of quick-drying colors, known as japan colors or coach colors, will be treated, suggesting the proper vehicle for each pigment, whether it be coach grinders' japan, japan gold size, varnish, etc., and how they are best tempered for certain special purposes. Colors ground in water without size (so-called distemper colors) and graining colors will also come in for a share, as well as tinted paste paints. To facilitate reference as to certain colors, each pigment is treated by itself, whether it be ground in oil, japan, varnish, water or any other vehicle, and the pigments will be taken up in alphabetical order, under separate headings, such as blacks, blues, browns, etc., etc. Under these headings each pigment belonging to the class will be dealt with, giving a short description of its nature, tests for value, how to select and treatment in mixing and grinding and nature of vehicle best suited for same, as well as the average percentages of pigment and oil or other vehicle required. A few remarks bearing on apparatus will not be amiss. No matter what the nature of the pigment may be, a thorough mixing is most beneficial, because it facilitates grinding; but permitting a mixer to run until it becomes heated is disastrous, especially in instances where the vehicle is japan or varnish, because it tends to render the mixing gummy on account of the evapora-

tion of the volatile portion of the vehicle. Nor is it good practice to add the pigment too rapidly to the vehicle in the mixer, for the reason that it not only produces imperfectly mixed material, but requires excessive power, which is wasteful expense. This is also true of the mills in grinding the colors in no matter what the vehicle may be, but, of course, more so, in the case of japan or varnish colors. Every mill should be well balanced and the grinding surface of the stones frequently dressed (i. e. made sharp) and given low breasts, so that the material can pass freely from the feeding eye of the mill to the grinding surface, otherwise it will not only gum up the material or make it ropy, but will waste motive power. The speed at which the mills should be run depends, of course, very much upon the diameter of the mill stones, but also upon the nature of the material. We shall consider this for the various colors as we go along, but may say that in the case of soft pigments, such as, for instance, lampblack, will yield a larger output per mill and per hour when the mill stones are of the Esopus (soft) variety than could be had if they were French buhr. The latter, however, are really necessary in the grinding of hard, gritty material, as in this case the material would be more apt to grind the surface of the stones, rather than the opposite. Years ago, the ideas of the practical color grinders as to fine grinding of oil colors, as well as coach colors, leaned toward limited diameters for the mills, and in some large plants may be found even to-day rows of iron mills of eight-inch diameter, though they are disappearing very fast and even mills of fifteen-inch diameter are being thought too small in diameter for some of the managers of paint factories of the present day. Mills of twenty-inch diameter are preferred, and,

when kept in good running balance and well dressed with proper grinding surface, colors in oil or japan may be ground out as fine as on a mill of eight or twelve inch diameter. But it is not every color grinder that has a large enough demand to run a sufficient quantity through a twenty-inch mill, and it would not pay him to use that size mill for a small quantity. Therefore, the original twelve-inch or fifteen-inch water-cooled stone mill is best adapted for the purpose. For grinding large batches of colors of light gravity in oil, such as lampblack, dropblack, etc., twenty-four-inch or even thirty-inch mills may be used to advantage, while for those of heavier gravity, such as mineral browns and reds, ochers, chrome greens, mills of twenty or twenty-four inch diameter are better adapted. Chinese or Prussian blues, raw and burnt sienna, raw and burnt umber and chemically pure greens—in fact, any color that is apt to be thrown from the flange of the running stone should be put through mills of not over twenty-inch diameter, same to be provided with a metal pan that is fastened to the legs of the mill frame and makes a gutter, catching the drippings from the flange of the lower stone, to which is fastened a scraper that cleans the gutter of color, discharging it through a gateway into the container provided for the purpose. That there is a very decided saving in the adoption of this plan should be very evident to the practical color grinder.

CHAPTER VII.

MIXING AND GRINDING BLACK PIGMENTS.

Bone Blacks.

Bone black, made from calcined bones, is found on the market in several grades, that made from freshly calcined bones being purest and best in tone. Recovered bone black, known as sugar house black, is also calcined bone black, used for refining (bleaching) sugar, which if not properly washed contains vegetable matter that prevents the black from drying as well as the freshly calcined bone black. While cheaper, it is not a safe pigment for paint, and the bulk of it is really used, without having been washed for fertilizing purposes on account of its contents of phosphate of lime. Bone black is often confused with animal black, which, however, is an error, as bone black must not contain any other material but the charred bones, while animal black contains all the charred or calcined refuse of animal matter, such as hoofs, horns, hair, skins, bones, leather, etc. Animal black varies to a great extent in bulk, density, staining power and hue, while bone black made from freshly calcined bones shows very little variation in depth of tone, bulk or strength. Pure bone black very seldom shows more than 15 per cent. carbon and 78 per cent. of ash that consists of 60 to 62 per cent. of phosphate of lime, the balance being carbonate of lime with traces of alumina and silica, sometimes also of iron. The color grinder will test bone black, which is usually offered under the name of pow-

dered drop black, for fineness of texture, for tinting strength with white and for oil absorption. When bone black requires less than 45 per cent. by weight of oil to 55 per cent. of the dry powder to make a smooth paste it should be viewed with suspicion as to purity, and when black is offered under that name that requires over 50 per cent. of oil to 50 per cent. by weight of black it is either not pure bone black or contains free moisture. Any kind of black should be bone dry before mixing in order to grind freely and make a smooth paste, more especially when it is to be ground in japan or varnish. Pure bone black is preferred by many carriage painters on account of its tooth as against the softer imported ivory blacks, though where intense covering capacity is desired, as well as absence of the grayish hue, the denser animal blacks or bone black with the addition of gas carbon black is preferred. While the various government service branches in their specifications for drop black in oil insist on pure bone black for the pigment, very few color grinders are placing a black of this kind on the market under the drop black label, as they strengthen the bone black by the addition of some Prussian blue or gas carbon black. This applies to the oil black. As may be gleaned from the price lists on colors in oil, the black listed as coach or drop black is quoted at similar price and the consumer will find the same quality in the container, no matter whether the label reads drop black or coach black. Bone black is very slow drying in oil, and, where not bound by specifications, the color grinder will do well to use a vehicle consisting of good boiled linseed oil or of 95 per cent. raw linseed oil and 5 per cent. first-class oil dryer.

Drop Blacks.

Drop blacks in japan, as noted above, may be made by mixing bone black alone or with an addition of gas carbon black or a very fine grade of well calcined lampblack, or a high grade of animal black, with what is known to the trade as color grinders' or coach japan, grinding until fine through water-cooled mills of twenty or twenty-four-inch diameter, taking care to keep the millstones from becoming overheated, also the product from skinning over by exposure to draught from open doors and windows. It is essential that the millstones are sharp and well balanced, because otherwise the material will gum up and make the addition of extra thinners necessary, which in turn will render the covering power of the black deficient. The less the number of runs a black in japan will have to pass through the mill the better for the opacity of the finished product. In some instances it has been found beneficial for the binding properties of these blacks to mix and grind them as stout as possible and when fine enough to pass the paste once more through the mill with the addition of a few pounds of good rubbing varnish to each fifty pounds of paste, thus obtaining a buttery product that breaks up readily in turpentine. Bone black is very seldom, if ever, ground in straight varnish, as it requires a pigment of lighter gravity for making the better grades of black varnishes for engine finishing and other work of that class.

Color grinders' or coach japan for grinding drop black must be of good body, free from turbidity or sediment and should weigh not less than eight pounds six ounces nor more than eight and one-half pounds per gallon. Must be free of benzine or heavy naphtha (now known as

turpentine substitutes), containing no other solvent or volatile matter but pure gum spirits of turpentine. Kauri gum is preferred by some consumers as the base of the japan, while others prefer it made with gum shellac. The black that is ground with japan made from kauri gum will set more slowly, drying more thoroughly, however; while, when ground with gum shellac japan, it will bind more rapidly, permitting parts touched up with it to be varnished over quickly without rubbing up, which cannot be done with black ground in the kauri gum japan. The average quantity of pigment and vehicle for a drop black in japan is equal parts by weight when pure bone black is being used.

For a denser drop black in japan would suggest forty pounds bone black and four pounds high-grade gas carbon black, both mixed together dry and dried over night in a temperature of at least 140 degrees F., then mixed with say fifty-six pounds of color grinding japan, and when fine a last run should be given, adding four pounds either of japan or rubbing varnish, which will make up for loss in grinding, yielding 100 pounds finished black out of a mixing of 104 pounds. Or animal black that contains at least double the quantity of carbon that is contained in bone black (which may be determined by assaying it with white for tinting strength, in comparison with bone black) may be used, mixing forty-eight pounds of the dry powder with fifty-two pounds japan, grinding fine and adding a few pounds of japan or rubbing varnish on the last or finishing run.

Ordinary bone black or animal black has no place on the palette of the artists, and these pigments are not

put up in artists' tubes under the name of drop black, Ivory black takes their place in that line. But they will be found in the distemper color list as drop black ground in water without size and are used by grainers when doing work in distemper and also by show card artists, who add glue or dextrine size for binding medium. When fifty pounds of dry bone black in powder are mixed with sixty-five pounds of water and the mixture is run through a color mill until fine, the result will be about 100 pounds of so-called drop black in pulp. The term is derived from the ancient custom of grinding the calcined bone black or animal black in water, throwing the resulting pulp on a filter, then forming the stiff pulp into drops of different sizes that were placed in drying rooms and so offered to the trade, that in those days consisted mainly of painters who by the use of slab and muller, or small hand mills, manipulated what small quantity of color was required for their purpose. The writer, as late as twenty years ago, purchased a lot of English drop black in the form of cones that weighed from eight to twelve ounces apiece and were baked so hard in drying that it was necessary to run them through a powerful crusher and then several times through a buhr stone mill in order to reduce them to powder. This practice is now obsolete, and the so-called drop blacks are obtained in powder of varying fineness.

Carbon Blacks.

Carbon Black.—While nearly all black pigments, and especially those most in use for paint making, owe their coloring principle to the element, carbon, when we at the present day speak of carbon black we mean the hydro-gas-carbon black produced by the combustion of

natural gas, the soot of which is collected on revolving plates and removed therefrom by fixed scrapers. When this gas carbon black was first placed on the market it commanded a price fully six times higher than it can now be bought for in quantity and was then, on account of its great staining power, mostly used for printing inks of a high type. Some twenty-five years ago, when in the Middle West the flow of natural gas was at its height and the demand for this black was not as great as it now is, it was offered at prices ranging from 25 to 60 per cent. less than those asked for it at present. At that time the average color grinder did not understand the manipulation of this black as it is understood to-day, and the black itself was not as well prepared, being much more granular and containing quite a large percentage of moisture. The black was then packed in sugar barrels containing fifty pounds net, but when kept in unheated warehouses or sheds it absorbed anywhere from 6 to 10 per cent. or more of moisture, which kept it from drying when ground in oil, even if certain percentages of siccative were added when mixing.

The present-day practice of packing this pigment in paper sacks not only keeps it from absorbing moisture in transit and storage, but prevents waste and facilitates handling and also cheapens the cost of packages. While carbon black has been ground and sold as lampblack or has been made use of in strengthening inferior grades of lampblack, that practice is pretty well abandoned, as the discriminating consumer of to-day is better posted than formerly, and can readily tell gas carbon black from lampblack by its hue and the tint it produces when mixed with white. Good lampblack burned from oil, when mixed with zinc white one part by weight of

the black to 100 parts by weight of zinc white, produces a bluish-gray tint, while carbon black produces a dull gray tint that would be called a smoky gray by most painters. Carbon black, in comparison with the better grades of pure lampblack, has a brownish hue, but is really blacker than any other form of black pigment. It has a granular form, but mixes more readily with water than lampblack of the better grades, and this is also a guide to distinguish it from lampblack. Take a glass tumbler or beaker of clear water and sprinkle a small portion of the black to be tested on the surface of the water and if carbon black it will soon sink to the bottom of the vessel, while lampblack burnt from oil will remain on top, even if container is shaken. Carbon black requires from four to five times its weight of linseed oil, according to its condition of dryness and fineness, to form a paste, and is best run through iron or steel mills, although it can be ground on soft stone mills, but the output on the iron mills is greater. Carbon black is not found as such in color grinders' price lists or catalogues, but, nevertheless, large quantities are ground in oil and listed under other names, generally velvet black or marine black.

The specifications of many railroads and other corporations are so designed that it is necessary to use carbon black along with inert mineral bases to obtain the depth of the standard furnished for black paint for equipment, as ordinary lampblack will not produce the black required. Printing ink manufacturers use enormous quantities of carbon black, but only the finest selected grades are used for lithographers and plate printers' purposes. These are ground on roller mills in specially prepared oil, known as burnt oil or lithographers' varnish.

Carbon black, as a base for black varnishes, must be specially selected for fineness and depth, and any that leans toward the very brown or grayish hue should be rejected for this purpose. Small quantities going a great way in this line, it pays the grinder to have a drying apparatus or oven, heated by exhaust steam or other economical means, fitted up with iron racks, on which the black may be placed in iron pans, so as to have all possible moisture driven off, as the black must be ground in varnish and moisture is to be avoided if good results are desired. The varnish in which the black is to be mixed and ground should correspond in quality to that which is to be used in thinning the black base to the consistency desired for use, and it depends upon the body of the varnish how much black can be incorporated. The grinding, of course, must be done on a water-cooled mill that is in perfect balance and condition, and great care is required to keep the mill from becoming overheated. It may take anywhere from eighty-five to ninety pounds of varnish to from ten to fifteen pounds of the black, depending on the more-or-less volatile nature of the varnish. Varnish that is inclined to liver or jellify with the black must not be used, as the resulting black varnish would be a failure.

Carbon Black in Form of Charcoal.

Charcoal blacks include blacks made from soft woods, the best being that charred from the willow, but some of the wood pulp mills have also charred their refuse and offered the resulting product as charcoal or carbon black. The latter has not found much of a market, as its texture seems to be too fibrous and refractory in grinding in oil or water. Charcoal black made from

willow twigs, however, has been made use of in some special structural iron paints, and has been especially recommended in that connection by late researchers in paint problems, with what real practical value is yet to be fully determined. It is claimed, however, that it has rust inhibitive properties, while gas carbon black is said to lack that feature.

However this may be, gas carbon black is a safe pigment when used with the proper inert material. It is a queer fact that this pigment has a specific gravity of 1.85 and requires anywhere from 80 to 84 per cent. of oil for grinding, while willow charcoal black has a specific gravity of 1.40 and yet requires only 35 to 40 per cent. of oil for grinding. This can only be accounted for by its very coarse texture. Vine black is very similar to willow charcoal black in every way—specific gravity and absorption of oil, texture, etc. Coal blacks have been put on the market under the name of carbon black, but have been found to promote rust and will not pass chemical investigation, for which reason these pigments are undesirable.

Frankfort black is a pigment that derives its name from the fact that it was originally made in that town, Frankfort-on-Main, in Germany, being calcined in closed vessels until thoroughly charred, consisting of a mixture of vine twigs, hop vine, the pressed residue of grapes, peach and prune stones, ivory and bone chips and shavings—in fact, every imaginable residue of that character. The calcined pigment is ground up in water, then well washed and floated and finally formed in drops and dried. The average chemical composition is about 60 to 65 per cent. carbon, 3 to 5 per cent. moisture, the balance mineral matter, con-

taining more or less phosphate of lime, according to the amount of bones or animal matter used in calcination. This black shows much variation and is scarcely ever used by color grinders at the present day in the United States.

Ivory Black.

While many in the trade do not make a distinction between drop black or bone black and ivory black, the latter, nevertheless, is, or at least should be, made from the waste of ivory in turning and cutting of ornaments, etc., but, as there would not be enough to go around for the demand of the trade, the manufacturers of ivory black make use of animal bones, selected especially for this purpose, especially the knuckles and shins of bovines, while ordinary bone black of extra fine texture and hue is also sold under the name of ivory black. The chief features that distinguish ivory black from ordinary bone black are greater fineness and brilliancy, and that it contains a higher percentage of carbon, which runs between 17 and 18 per cent., as against 14 to 15 per cent. in ordinary bone black. While the specific gravity of bone black is 2.70 on the average, ivory black has a gravity of 2.60 to 2.65, but resembles bone black in all other respects, excepting fineness and depth. The best ivory blacks were obtained from the Taunus in Germany, through some German and English exporters, and the selling prices at one time were rather high, in some of the better grades reaching four or five times the price of ordinary powdered bone black, and even now it is treble that of the latter. As to the grinding of ivory black, all that has been said in reference to bone black applies here, excepting that a trifle more vehicle is required for mixing and grinding in oil as well as in japan.

Unless specifically required, ivory black is not ground in oil for the trade, but bone or animal black is so labeled. For the use of the coach and carriage trade, however, ivory black is ground in coach japan or gold-size japan and sold at an advance in price under the label of "Coach Ivory Black" or "Ivory Drop Black." As it was the custom of the manufacturers of ivory black to add some blue, either Chinese or Prussian blue, also ultramarine blue, to the black to increase its depth in oil, the color grinder must look sharp toward avoiding the use of a blued ivory black when grinding it in japan or varnish for this trade, for the reason that the user thins the black with turpentine, which will make the blue float to the surface, and in finishing the surface with varnish there will be a smoky or greenish effect, according to the nature of the blue used. There is no black pigment that excels ivory black in brilliancy for fine coach and carriage work, and for high-grade enamel making a base made by grinding ivory black in varnish has no superior. The proportions of black and varnish required vary according to the consistency of the varnish used in grinding. Ivory black is supplied to artists ground in poppy seed or nut oil, although there seems to be no special reason for selecting such a vehicle, as linseed oil, well settled by age, will serve the purpose fully as well.

Lamp Blacks.

Lampblack without question is the black pigment most commonly used of all the line of oil colors, and no assortment of these is complete without it. Of course, very large quantities of lamp black are sold in the dry powder, packed in round papers or square paper boxes

from one-fourth pound to one pound. The brands most popular are known as Germantown, with a special trade-mark, such as "Eagle" or "Bear," etc., for the best grade, also "Old Standard," or "Ordinary," "Star," "Coach Painters'," "Sign Writers'," or other fancy names. These do not interest the color grinder, as he buys the material in bulk, packed in casks, barrels or sacks. While formerly Germantown lamp black in bulk was a favorite with color grinders, the keen competition of the last two decades forced them to look for lamp black of greater staining power and induced lamp black manufacturers to cater to this want. To be up with the procession every color grinder must have for his best brand at least a lamp black that will, when ground in oil to the usual paste consistency, show twice, or nearly twice, the tinting strength of the better grade of Germantown lamp black, and when separated from the oil in which it is ground in a chemical analysis it must not show more than two-tenths of 1 per cent. of mineral ash if it is to pass the specifications issued by government service departments. Nor must such black show any unburnt oil or tarry matter, as their presence retards the drying of the pigment when ground in oil. To ascertain the presence of such undesirable matter a very simple test is sufficient. A small hillock of the dry black is placed on a piece of perfectly white blotting paper and the black saturated with sulphuric ether. The ether will be absorbed by the blotter, forming a ring or halo on the outside of the black, and if any empyreumatic matter is present in the black the ring will show yellowish or brownish discoloration, whereas if it remains clear the black is free from such deleterious matter. The next thing is to test the black for absence

of grit and also to try it out for tinting power by assaying it in the usual manner with zinc white, comparing it with an adopted standard.

To be perfectly safe when selecting grinders' lamp black on large orders or contracts the color grinder should secure enough of each black offered to make a practical mixing and grinding, so as to ascertain the exact percentage of oil required for each brand of black under consideration, and by making his tests for fineness and strength with the finished products in comparison with one another he will have no trouble to decide which of the blacks it is most advantageous for him to use. A lamp black of this description has a specific gravity of 1.80 to 1.84 and will require seventy-five to seventy-six pounds of oil for every twenty-four to twenty-five pounds of the dry black to form a buttery paste that will break up nicely when being thinned for use. To grind it in oil iron or steel mills are preferable to stone mills, because increasing the output, while buhr stone mills should not be used at all for grinding lamp black in oil. Lamp black of the class here described is soft and esopus stone mills will turn out a smooth paste. All of the foregoing refers to lamp black made from residuums of oils, fats, greases, petroleum and tar oils. When black is offered that is made from vegetable matter it can be readily identified by its harsher, coarser texture and its heavier gravity. A grinders' lamp black of the above description when packed in flour barrels will weigh no more than thirty pounds net. while a sugar barrel will hold about forty-five pounds—a sugar barrel will hold about sixty pounds of a fairly good grade of Germantown lamp black. Commercial lamp black as a rule is very heavy in gravity and a flour

barrel will hold as much as 100 to 120 pounds, but it is scarcely ever used in color grinding, excepting, perhaps, in cheap black paints where it is necessary to economize in the use of oil.

As we have remarked when speaking of carbon black it is very difficult to mix oil lamp black with water, and when lamp black is wanted ground in water carbon black is, as a rule, substituted for it, although by the exercise of much patience lamp black can be mixed and ground in water. Place the required quantity of dry black in a mixing pot of convenient size, then put water on the powder, little at a time, to saturate and let stand over night. Making the water alkaline with carbonate of soda will also aid in obtaining a mixture, one ounce of soda to twenty-five pounds (three gallons) water.

Lamp black in japan is not much called for at present, still it is listed by coach color manufacturers and is being used by sign painters for quick work and for similar reasons by some coach and carriage painters. For this purpose it is best ground in three parts coach japan and one part turpentine, rather stiff in consistency, on a twenty-inch or twenty-four inch water-cooled mill (iron or steel mill preferable) and then to every forty-five pounds of the product should be added five pounds of good rubbing varnish, running this mixing loosely through the mill. A good average formula would be as follows:—Twelve pounds grinders' lampblack, twenty-seven pounds coach japan, nine pounds gum spirits of turpentine, equal to forty-eight pounds. Result, about forty-five pounds paste. Add five pounds rubbing varnish. Final result, fifty pounds lamp black in japan, with excellent working, drying and binding properties.

Lampblack in oil in tubes is not called for by artists, but sign writers favor it put up in large tubes, as well as tin cans, under the brand, "Sign Writers' Black." Some makers simply grind lampblack in boiled linseed oil with a portion of drier, while others again grind gas carbon black in raw or boiled linseed oil with sufficient japan drier. The latter being more jet black is in favor as a ground for smalting black signs.

Black Lead (Graphite or Plumbago.)

This has hardly a place on an oil color list, yet it belongs properly to the group of black pigments. Years ago we only had the natural mineral at our command, but for some time it is produced also by artificial means. By this we refer to the product of the Acheson Graphite Company, who claim that this is purer by far than the purest natural graphite. The Acheson graphite, it is claimed, contains 94 per cent. pure carbon, the balance being silicious matter with traces of alumina and iron. There are, however, offered to the trade natural graphites containing 90 per cent. or a trifle over of carbon, and it is really a question of choice for the color grinder, unless the artificial product is specified. The natural graphite with 90 per cent. of carbon averages about 2.5 specific gravity, while the artificial is not above 2.25. Either of these will require about 45 per cent. of oil, or say, forty-five pounds oil to fifty-five pounds pigment to form a paste. The artificial pigment does not hold well in suspension, is very apt to cake hard in bottom of container—much more so than the natural graphite. To hold the pigment in suspension an inert extender, such as asbestine or a bouyant clay, is beneficial, the only drawback being that graphite of itself has not a

great deal of opacity. When not tied down by specifications the color grinder or paint maker can remedy this deficiency in body or hiding power by the addition of lampblack, especially when, as it is often the case, black graphite is called for.

Mineral Black.

So far as the demand by painters is concerned, this might be as well omitted from the lists of oil colors. But there is quite a demand for it from industrial concerns, where a great deal of metal is to be coated. However, there is no established standard for the material sold under this name, with the exception of specifications issued years ago by the United States Navy Department, which call for a black paint to be composed of natural mineral containing not less than 15 per cent. carbon, 5 per cent. lead oxide in the pigment, balance to be inert material as occurs in nature with bituminous shale, etc., to be ground in boiled linseed oil. The black fillers mined in Pennsylvania near Muncy form a basis for blacks of this class and also for iron fillers, etc.

What is known and sold to the trade as dry mineral black differs however, from the fillers in question, as well as from that which is specified by the Navy Department. As a rule, it is not a safe pigment to use with oil, as it appears to contain a great percentage of soluble salts, principally iron sulphate, and we would caution grinders to make very close examinations of the material offered before adopting same for use in oil paint.

There are a few other black pigments to which we did not refer because they are practically obsolete, there being no demand for them. These comprise candle

black, lead black, manganese black, Prussian black, and prussiate black, and black lake, which latter fades rapid on exposure to light and air. Prussian black is simply Prussian blue blackened by calcination. Prussiate black can only be used as a decolorizing agent, being a residuum from yellow prussiate of potash. Lead black is the black sulphite of lead and has no place in color grinding. Manganese black is simply black manganese oxide.

CHAPTER VIII.

MIXING AND GRINDING BLUE PIGMENTS.

Antwerp Blue.

Antwerp blue is now seldom in demand, although up to about fifteen years ago it was called for ground in poppyseed oil for artists' use, also in japan and varnish for special coach work, and even in water for fresco work. At that time it was imported from France or Belgium packed in cases of ten kilos and marked "Bleu Mineral" (mineral blue). It is as difficult to obtain it to-day from New York importers as it is to find a needle in a haystack. There is nothing so remarkable about the color or tone of this blue, but, while the text books say that it is almost identical with Prussian blue, only paler in color, the color grinder will find it extremely difficult to match the particular shade of the Antwerp blue that is furnished in artists' tubes by Winsor and Newton and Continental manufacturers of artists' colors. Some color maker friend will tell him to take three or four pounds Prussian blue and one pound alumina hydrate, mixing the two pigments and have the exact tone and shade, but if he accepts the advice he will be disappointed. Our advice is to select a Prussian blue that lacks the bronze cast, but is strictly pure, adding one part finest blanc fixe by weight to two parts of the dry blue, and if the shade is not pale enough lighten the color with the addition of as little French zinc white as possible. Made by this method, the pigment is not so apt to liver in oil or japan as it is when made with alumina hydrate, besides it will have

better body. To grind in poppyseed oil, figure on 35 per cent. vehicle and 65 per cent. pigment, for coach color figure on 40 per cent. gold-size japan and 60 per cent. pigment, for distemper color figure on equal parts pigment and water for mixing.

Berlin Blue.

Berlin blue is not listed in the catalogues of paint manufacturers in the United States. The pigment belongs to the Prussian blue group and the name simply a synonym for commercial purposes. Will be dealt with under "Prussian Blues."

Bremen Blue.

Bremen blue consists mainly of hydroxide of copper CuH_2O_2) with small portions of copper carbonate ($CuCO_3$), and so far as its use in oil is concerned it is obsolete. Even in its dry form, as it was sold to decorators for distemper and fresco painting, it has been replaced by ultramarine blue and imitation of cobalt blue.

Blue Verditer.

Blue verditer, a copper blue very similar to Bremen blue, is still in use by artists to a small extent, both in oil and in water, especially in the latter form, but, not being permanent to light, the demand is very limited. The pigment varies considerably, according to the method of manufacture, hence it is difficult to give an accurate figure as to its absorption of oil in grinding, but 40 per cent. poppyseed or nut oil and 60 per cent. by weight of pigment is about a good average to figure on.

Brunswick Blue.

Brunswick blue is simply an extended color, consisting of Prussian blue and barytes and in such proportions as the fancy of the maker or his selling price and profit-making idea would dictate. It may consist of 10 per cent. Prussian blue and 90 per cent. barytes or of equal parts blue and barytes, and it is not at all necessary to have the blue extended by the color maker—in fact, it is far more economical and more accurate to let the addition of the extender be made in the mixer when getting ready to grind it in oil. To make a batch of 100 pounds of Brunswick blue in oil with only 10 per cent. color in the dry pigment, place in the mixer seventeen pounds Prussian blue that has been ground fine in linseed oil in the proportions of equal parts by weight of pigment and oil, add seven pounds more raw linseed oil and seventy-six pounds finest floated barytes. If the blue is free of paint skins and the barytes really fine, a thorough mixing will make the paste smooth enough for such a low-priced blue, otherwise run it through a mill until smooth and fine.

Taking for granted that the Brunswick blue is to consist of 50 per cent. pure color in the dry pigment, a mixing on these figures will give the desired result:—Sixty-five pounds Prussian blue in oil, as above, add thirty-two and one-half pounds of finest barytes and two and one-half pounds raw linseed oil, and follow above suggestions.

This suggestion would apply also to this blue in japan, with this proviso, however, that here a 10 per cent. pure color in the pigment would not answer, but, figuring on a blue to consist of 50 per cent. pure coloring matter and 50 per cent. barytes, we would conclude that

the mixing should be based on the following:—Place in the mixer seventy pounds pure Prussian blue that has been ground fine at the rate of 40 per cent. pigment to 60 per cent. by weight of gold-size japan and add twenty-eight pounds finest floated barytes (bone dry) and two pounds gold-size japan or good rubbing varnish. Mix thoroughly and if not smooth enough give it one run through mill to finish. This is not pure Prussian blue, and it is not to be offered as such, but as Brunswick blue in japan, and if the materials are all right in the first place it will be an excellent working material. It is made on the same plan and rather a little better than the coach colors and colors in oil that made one manufacturer immensely rich some thirty-five years ago.

Chinese Blue.

Chinese blue is really a fine grade of Prussian blue, having a much better luster than the ordinary grade, and when in the lump form its fracture must show a decided bronze cast or luster, by which Chinese blue is distinguished from the ordinary Prussian blue. It should have a somewhat greenish undertone in comparison with the violet of the Prussian blue. When used for tinting whites, Chinese blue must give a clear sky-blue tint, neither leaning to green nor to the lavender-gray. In selecting the dry blue for grinding in oil, the color grinder must examine the powder, if he buys in that form, for softness, as it is very difficult and expensive to grind a hard blue that has been dried too rapidly. It should also be very thoroughly examined to see that the powdered material has not been scorched in the mill, as it is very apt to catch fire from the accidental

presence of iron. The utmost care is necessary in mixing and grinding the blue in oil, japan or varnish to not only exclude particles of iron, but also to prevent overheating. Well-dressed soft stone mills, running at fairly slow speed, are best adapted to grind this blue, as well as Prussian blue, as excessive heat will ruin the tone and luster of these pigments. Pure Chinese blue requires its own weight of linseed oil to produce a commercial paste, but if wanted of extraordinary tinting strength it may be ground at the rate of 56 pounds dry blue to 33 pounds linseed oil and 11 pounds turpentine. The result, however, will not be over 95 to 96 pounds paste, as a good portion of the turpentine will be lost through evaporation during the grinding process. This practice will hardly appeal to the manufacturer of the present day and the lesser cost of oil will induce grinders to use all the oil consistent with producing a marketable article.

When a color grinder desires to place an extended blue on the market he will scarcely use the higher-priced Chinese blue, but make use of an ordinary Prussian blue, hence Chinese blue, when so labeled, will usually be found strictly pure. While Chinese blue is preferable to Prussian blue in artists' tubes, it is not well adapted for grinding in japan or varnish for the use of the coach and car painter on account of its bronze luster, which, if the blue is used solid, floats up when the color is thinned with turpentine, and in drying the surface, instead of showing a deep blue effect, gives a brownish surface when under varnish. This is most noticeable when Chinese blue is being used to make a composite green for coach work instead of the bronzeless Prussian blue of the violet tone.

Prussian Blue.

Prussian blue, also known as Paris blue or Berlin blue, requires the same general treatment and precautions in mixing and grinding as Chinese blue, differing from the latter only in the method of making the dry blue and in the more or less marked absence of bronze luster. The paler shades of Prussian blue resemble Chinese blue to a great extent, producing the clear sky-blue tint with white, while the darker shades usually give the lavender-gray tint with white. For admixture with black and yellow in making composite greens, however, the dark Prussian blues are best adapted for the reasons above mentioned. Before mixing Prussian or Chinese blue in oil or japan or varnish it is essential to have the pigment almost bone dry, and unless it can be procured in that state the pigment should be mixed in a steam-jacketed apparatus at a temperature of not over 140 deg. F. to drain off all the moisture possible. Where much of the blue is being manipulated, a so-called sifter and drier will not prove very expensive, while in smaller establishments the pigment may be dried on metal pans in a drying oven or drying room. This is especially necessary when the blue is to be ground in gold size japan or varnish, but it is also beneficial for ordinary oil color. Equal weight of pigment and linseed oil will produce a satisfactory paste, when good pure Prussian blue is used, while for the coach color trade it should be mixed and ground in gold size japan, when about 40 per cent. by weight of pigment and 60 per cent. of japan will be the average proportion. For making blue enamel a practically bronzeless blue should be ground in, say, 75 pounds rubbing or finishing varnish to 25 pounds of the dry blue, the quality of the

varnish to depend upon the purpose for which this varnish base is required, but also upon its properties as a grinding vehicle.

When Prussian blue as an oil color or paste paint in oil is to be extended, alkaline extenders must not be used. This bars out the use of whiting, asbestine and blanc fixe or barytes, unless the last two pigments are well washed and prove to be inert by test. Floated silica, gypsum, china clay, floated barytes and blanc fixe (the two last named if free of alkali) will serve as extenders, the best being a mixture of china clay and gypsum. Whiting and asbestine always show appreciable traces of alkalies, and the presence of these is very apt to change the tone of the blue to a reddish tinge. While Prussian or Chinese blue cannot be made use of by decorators in distemper painting, so long as they employ a whiting base there is some slight demand for these blues and color grinders who have a color-making establishment connected with their factory will not mix and grind the dried blue in water, but will use the pulp instead, simply making it smooth by running it through a mill.

Bronze blues, reflex blues, steel blue and night blue, or whatever may be the fancy names given to that class of pigment, are of the Prussian blue group and characteristics and used for special purposes, principally for the preparation of printing and lithographing inks. The manufacture of these inks is usually carried on as a special line of business, and the larger establishments prepare their own colors from the raw materials. So, for instance, in manipulating Chinese or Prussian blue, as well as the special blues referred to in the last paragraph, the pulped blue is not dried by heat, unless there

is an excess on hand, which it is desired to market in the dry state. The pulp blue that is about to be used for ink is either well drained of its water (the so-called liquor) or filter-pressed and then placed in a horizontal mixer, containing bronze blades for beating the pulp and provided with a steam jacket to drive off the moisture. While the pulped blue is thus beaten, the so-called burnt oil or lithographer's varnish of the required consistency for the kind of ink wanted, is added, a portion at a time, which facilitates the evaporation of the moisture, at the same time keeping the pigment soft and in fine division. From this mixer the ink is placed on mills with three rollers of hardened steel, or, still better, of fine polished porphyry, until fine enough to pass the test. The usual proportions for mixing and grinding are from 30 to 33 pounds of blue, figured dry, and 67 to 70 pounds of lithographers' varnish No. 1 or equal parts by weight of No. 1 and No. 2.

Leather blue is also of the Prussian blue type and is called for by leather dressers, who require the blue ground fine in linseed oil, of which they add certain portions to the black dressing that they prepare for their use by heat. The paste for this purpose should consist of 45 parts by weight of bronzeless blue and 55 parts by weight of pure well settled linseed oil. It is added to the black for the purpose of giving the dressing greater density and greater depth.

Celestial blue of commerce is not in demand as an oil color by the trade, and what little is still being purchased is in the dry form and does not interest the color grinder, as it is simply a very much extended Prussian blue that may contain anywhere from 6 to 20 per cent. by weight of blue, balance being natural barytes, as there is no standard for blue of that name.

Cobalt and Ultramarine Blues.

True cobalt blue is only interesting to the color grinder so far as its use by artists is concerned, while for all other purposes the artificial ultramarine, known to the trade as imitation of cobalt blue, which can be obtained in several grades and shades, is being placed at the disposition of the consumer. While true cobalt blue is of great permanency and unaffected by the most destructive agencies, it is too high in cost for general use, and really the artificial ultramarine, sold as imitation of cobalt blue, gives a much more brilliant color effect. However, the latter should not be put up for the use of the artist, excepting when label states plainly that it is artificial or imitation. True or genuine cobalt blue is a compound of the oxides of cobalt and alumina with some phosphoric acid, occasionally. It works better as a water color than it does in oil, and is highly valued on that account among moist colors used by artists. Grinding it for artists' use in oil to be put up in tubes will require 35 per cent. dry pigment to 65 per cent. by weight of bleached poppyseed or nut oil, either of which is preferable to linseed oil for this purpose. Cobalt blue has a greenish tone, that when viewed under gaslight is more or less violet. True cobalt blue is readily distinguishable from its imitation by being unaffected in contact with acids and strong alkalies that affect the artificial brands. It has also been known as Thenard's blue and azure blue. Its cost being prohibitive, it is not placed on the market as a coach color or as an enamel.

Cobalt blue smalts, a glass consisting of a double silicate of cobalt and potash with such impurities as the oxides of iron and calcium, was very largely ground up

in various vehicles and sold as cobalt blue before the advent on the market of the lower-priced imitation of cobalt blue made by the manufacturers of artificial ultramarines. The latter show a far more brilliant color effect, much stronger hiding and staining power and are not affected so much in tone by electric or gas-light. Imitation of cobalt blue is offered to the color grinding trade in various depths of shade, the marks of the best quality being C. S. or C. 9, another lower-priced brand being marked C. C. or C. I. When pale shades are required, a portion of French process zinc oxide added to the blue will produce very fine light effects. These blues are for many purposes more desirable than some of the artificial ultramarine blues, as they make colder blue tints with white, not leaning so much to the purple or violet rays. Nor are these imitations of cobalt blue so readily affected by the presence of alkalies, as is the case with the soda ultramarines. For mixing and grinding the best grades of imitation of cobalt blue in oil, figure on 35 per cent. oil to 65 per cent. pigment, but when zinc is added to produce a lighter shade reduce the percentage of oil proportionate to quantity of zinc used. For making an azure blue color in oil or japan, when zinc oxide can be employed as base, imitation of cobalt blue should serve best as coloring matter, but when white lead forms the base, Chinese blue will prove superior for standing exposure. This blue is favored to some extent for carriage painting, especially for striping and should be ground in pale gold size or rubbing varnish, and when toned with a small portion of zinc oxide produces a rather pretty blue stripe. But it will prove very effective as a body color for some small vehicles. To mix and grind the pigment for this purpose, figure on 54 per cent. by

weight of Super. Imitation Cobalt Blue, 6 per cent. of best French zinc (no more) and 40 per cent. of pale gold size japan, or 35 per cent. of this and 5 per cent. good pale rubbing varnish. Imitation of cobalt blue is not favored as a base for blue enamel on account of its settling tendency in liquid form. To grind it in water for distemper work, figure on 70 per cent. pigment and 30 per cent. water. As cobalt blues do not appear in lists of second or third grades of oil colors, we need not mention extenders for this blue, but we may say that it is very necessary to examine these blues as well as artificial ultramarine blues for the presence of free sulphur before mixing the pigment in any oil, japan or varnish vehicle. Either free sulphur or free soda will give trouble in grinding, as either will act on the vehicle, producing a gummy paste of livery tendency that also tends to cake in the containers. The writer has had occasion to reject supplies of ultramarine blue that had such a strong odor of sulphur that it required no chemical test. However, it is always best to take no chances when the material gives the least cause for suspicion.

Ultramarine blue in its true or native state is found in Tibet, Persia, China, Siberia and in the Andes of South America as a mineral, called "lapis-lazuli." It is mostly found in pebbles, associated with a gangue of iron pyrites, limestone or other rocky substance, according to the formation of the earth in which it is found. The process by which the mineral is made into a workable pigment is not interesting to the color grinders, as it may be said to be a classic or dead, rather than a live paint material, excepting perhaps for the ceramic art and a small class of artist painters. Suffice it to say that the native product lacks the

brilliancy of the best grades of artificial ultramarine blue. It is very harsh and granular in texture and somewhat refractory in grinding. In oil it is rather transparent, while the artificial product is more opaque and has far greater tinting power. To grind true ultramarine blue in oil for the use of the artists it will be found that 60 per cent. of oil to 40 per cent. of pigment are a good average to figure on, but as the specific gravity varies considerably these figures are not to be depended upon. True ultramarine blue is not put up as a distemper color, and if any one desired it in that form and did not mind paying the price it would have to be manipulated specially for such demand. As such occurrence is hardly liable to happen, we will pass on to the consideration of artificial ultramarine blues. There are two distinctive processes or methods of preparing this pigment, one being known as the sulphate ultramarine, the other as soda ultramarine, the latter having the violet undertone, the former leaning to a more greenish tinge. In either process the constituents are nearly similar, comprising kaolin (china clay), sodium sulphate, sodium carbonate, sulphur, coal or charcoal, rosin, quartz and infusorial earth. All of these are not used in one operation, if, for instance, quartz is used, infusorial earth is omitted and vice versa, or when charcoal is used, coal is omitted and so on. When sodium sulphate is used less sulphur is added to the batch, but in that case the sodium sulphate must be increased proportionately, and the more sulphur is used in soda ultramarine the deeper the shade and tone.

Sulphate ultramarine blue may be recognized by its having a slightly greenish-blue cast when ground in oil, while soda ultramarine blue has a violet-blue character.

The former shows more silica and less sulphur and sodium in an analysis, and when tested for tinting effect with white gives a clearer blue, less grayish tint, than the latter. The better grades of ultramarine blue show average analysis as follows:—Sulphate ultramarine blue—Silica, SiO_2—48.5 per cent.; alumina, Al_2O_3—23.2 per cent.; sulphur, S—9.6 per cent.; sulphur trioxide, SO_3—2.6 per cent.; sodium, Na_2O, 12.8 per cent.; water, HO_2—3.3 per cent. Soda ultramarine blue—Silica, SiO_2—40.8 per cent.; alumina, Al_2O_3—24.3 per cent.; sulphur, S—13.6 per cent.; sulphur trioxide, SO_3—4.4 per cent.; sodium, Na_2O—14.7 per cent.; water, H_2O—2.2 per cent. The former is much paler in shade, the latter very much deeper. The better grades of soda ultramarine blue are preferred for bluing white pigments, because the whites so blued are not so apt to green off, especially when varnish is used in reducing the white for application with the brush or for dipping.

Color grinders know what a large variety of grades ultramarine blues are offered in and how the selling prices of the dry blue differ, as well as the advance in the market prices of to-day, as compared with those of years ago. There was a time not so very long since when there was spirited competition and the makers of ultramarine sold the color at ruinous prices, but since the consolidation of interests both in this country and abroad the prices have gone up at least 75 per cent. from those referred to. It is not our purpose here to extol any special brand or manufacture, but we must state that the brands manufactured in the United States are always preferred on comparison of quality and prices to those imported from abroad, excepting in

rare instances, where extra brilliant, soft material is required and higher cost not considered. There being a dozen or so of grades listed, of which at least one-third will interest the color grinder for his various purposes, it is up to him to test samples offered him by the manufacturer for brilliancy of tone, shade, fineness, softness of texture, tinting power and clearness of tint produced with white. One part of the dry blue mixed with 25 parts French zinc white, rubbed out to the utmost is the best guide for this. As the percentage of silica and alumina, etc., in ultramarine blue does not figure much in the oil absorption for grinding the oil color, it is not necessary to go to the trouble of grinding specimen batches, as in the case of blacks, rubouts being sufficient for testing ultramarine blue.

For grinding ultramarine blue in oil for the trade the one that has the strongest staining power should be selected, and the average mixing will require two-thirds by weight of pigment to one-third by weight of linseed oil. Refined oil is preferable to raw or boiled oil, as it will give the blue a clearer tone and appearance. For coach color the blue with the cleanest tone is preferable to that of the greatest staining power.

For coach work and automobile painting this blue should be ground in pale gold size, as the brownish color of the ordinary coach japan is apt to impart dullness to ultramarine blue. Care must be taken that the pigment is bone dry before mixing, and for extra fine work the blue is best ground in pale rubbing varnish with a portion of turpentine, 40 per cent. by weight of gold size japan or 32 per cent. of rubbing varnish and 6 per cent. turpentine to 60 or 62 per cent. by weight of pigment will be required to produce a smooth paste.

For ultramarine blue enamel a small portion of best French zinc added to the pigment, not enough, however, to affect the shade to any great extent, will be beneficial, as it will tend to hold the color in better suspension when reduced to brushing consistency. The pigment in this case, when intended for air-drying enamel, is best ground in pale gold size, but when it is intended to serve as the base or coloring for baking enamel, that is to be stoved, at fairly high temperature, the grinding vehicle should be baking enamel varnish of the proper selection and the pigment and varnish should be about equal portions by weight.

Artificial ultramarine blue, while not as permanent as the natural, is on the lists of artists' tube colors, as it is, when properly selected, deeper and more brilliant and very much lower in price. The finest and softest imported ultramarine blue in the form of drops should be ground in poppyseed oil to rather stout paste, and if good aged oil is used in the grinding the oil will not separate from the pigment when the color is squeezed from the tube on to the artists' palette. The separation of oil and pigment can be entirely avoided if the blue is ground in a mixture of 75 parts of bleached poppyseed or nut oil and 25 parts of palest lithographer's varnish, which latter will in no way interfere with the durability and permanency of the color, 65 parts by weight of the ultramarine blue in drops to 35 parts by weight of the oil mixture will be about the right proportion.

Ultramarine Blue in Distemper.

For this purpose the sulphate ultramarine should be selected, and when 70 pounds of the dry blue are mixed with about 40 pounds (or nearly 5 gallons of water)

and run through a stone mill until fine, the result should be 100 pounds of a smooth paste that will keep well for months in well-sealed jars.

Ultramarine Blue for Barrel Paints.

Since the petroleum trade began to assume its great proportions half a century ago, enormous quantities of barrel paints have been made, and for a time at least the greatest consumption was in blues, because the practice was to paint only the heads of the oil barrels in white or yellow or buff; while the bilge of the barrels were mostly painted in various shades of blue, the base of which was ultramarine, because whenever Prussian blue was used as tinting color, the paste, on standing about, suffered a change in a short space of time, not only becoming much lighter in shade, but also turning to a dull greenish tint. This is partly due to the alkaline properties of the carbonate of lime (whiting) in the pigment, but more so to the acidity of the rosin in the benzine and rosin liquid, which is the vehicle for barrel paints in paste form. As a rule, blue barrel paints in paste form for the petroleum and cottonseed oil trades and whatever other trades will use them to a minor degree are composed of a low-priced ultramarine blue. American zinc white or lithopone and whiting (chalk) or a mixture of whiting and terra alba (gypsum), ground in a vehicle commonly known as gloss oil, and consisting of about 425 pounds of medium colored rosin, dissolved with or without heat in 50 gallons petroleum spirit (62 deg. benzine). The heavy benzines now on the market will not answer the purpose, being too slow in evaporation, causing the paint to require too long a time to dry. Rosin is now practically 150 per cent. higher than it was

five or six years since and benzine is nearly three times the price of one year ago. As nearly all consumers or concerns using these paints have their own standard shades, it is not practicable to give a formula here, but we may say that because of the keen competition among grinders the margins of profit are very small, even if the goods can be sold in very large quantities.

Miscellaneous Blues.

Lime blue, a pigment made from solutions of copper salts with the addition of sal ammoniac and quick lime, really a mixture of copper hydroxide and calcium sulphate, has gone out of use and a cheap grade of ultramarine blue has taken its place.

Caeruleum is the name of a blue found on the decorations of ancient temples, but its preparation is a lost art, and what little is now sold under this name to artists appears to be a combination of the oxides of cobalt and tin. Indigo blue, too, does not interest the color grinder, excepting for its use in specialties, such as printers' ink or for pharmaceutical use. It is best purchased in the lump form, as the powder is often badly adulterated. The color and tone of indigo can be successfully imitated by a mixture of Prussian and ultramarine blue by adding sufficient ivory black. If the color grinder has occasion to use it he had best steep it in alcohol for a few days, beat the mixture up fine and evaporate the alcohol before adding the oil or varnish.

CHAPTER IX.

MIXING AND GRINDING BROWN PIGMENTS.

The pigments comprising this group include asphaltum, bistre, bitumen, Caledonian brown, Cassel or Cologne earth, mineral or metallic brown, sienna, raw and burnt; umber, raw and burnt, sepia and Vandyke brown. Asphaltum is of far greater interest to the varnish maker than it is to the color grinder, the latter's chief use for it being for the artist's color list. For this purpose only the genuine Egyptian or Syrian asphaltum, as the product from the Dead Sea is known to commerce, should be selected as other grades vary too much in their nature, containing too great a percentage of hydrocarbons.

To prepare asphaltum for artists' use in the safest manner is to take the grade referred to and subject the crushed material to a slow heat in an iron kettle, gradually raising the temperature to 480 deg. F. until it becomes like a cinder, then, when cooled, crushing it to a powder, which is soaked over night in enough spirits of turpentine to cover it and then mixed with and ground in borate of manganese boiled linseed oil of good body until impalpably fine. In this way the color is not treacherous as are some of the asphaltums prepared as an oil color for artists with the addition of wax, shellac or Venice turpentine. When asphaltum is wanted for water color painting or for overgraining in distemper, it is treated by heat as above to drive off the hydrocarbons, when the powder may be stirred in a solution of strong ammonia, thus giving up its coloring matter to a great extent. The solution is then precip-

itated by adding acetic acid, the top liquor decanted and the precipitate washed to remove both alkali and acid as much as possible. This done a little gum arabic or dextrine and glycerine is added and the mixture partly dried to acquire the right degree of consistency. Aside from this the color grinder has not any use for asphaltum, excepting in the form of varnish that comes to him in ready prepared style.

Bistre is used as a water color only and very rarely at that. It is the collected soot of beechwood, and when well washed with hot water until no more soluble matter is extracted, the soot is dried and ready for use after the gum water and glycerine are added. It is sold as moist color in cakes, has a rich brownish-yellow tint and is used as a wash for water color paintings, but is not very permanent.

Bitumen is simply another name for asphaltum, and what we said about the latter applies here. Bitumen of Judea is simply the asphaltum procured from the Dead Sea, where it is said to be cast up by the water.

Caledonian brown is hardly known here and may be simply classed as a native brown oxide of iron, consisting of quite a high percentage of manganese oxide in combination with iron oxide. In the raw state it almost resembles a light shade of metallic brown, but when calcined or burnt it looks like an inferior Vandyke or Cologne brown.

Cappagh brown, which is referred to at length in some of the text books from the other side of the Atlantic, has very little interest to the color grinder on this side, there being no demand for colors of that description, and we cannot really see why an artist should have a desire to have colors of the character of this type on his palette, no more so than he should care for Prince's

metallic or other mineral browns. However, an analysis of Cappagh brown by A. H. Church, in his "Chemistry of Paint and Painting," would indicate that this pigment only differs from Turkey or Cyprus umber in so far that it shows a much greater percentage of manganese dioxide and less ferric oxide, while the total percentage of the two oxides is about the average of the totals found in umber, when the difference in hygroscopic and combined moisture is taken into consideration. Cassel or Cologne browns (or earth) are pigments of natural origin. They vary in composition and are imported into this country under the name of Vandyke brown and will be considered under that caption.

Mineral or Metallic Browns.

Mineral browns, or, as they are more familiarly known, metallic browns, are pigments containing more or less sesquioxide of iron with a portion of inert materials as they occur with the iron oxide in nature, such as alumina, silica, with traces of lime and manganese. These ores are found in their best composition in the Lehigh Valley region of Pennsylvania, but also in Virginia, Tennessee and Alabama. The ores found in Pennsylvania are in two varieties, one being natural hydrated oxide or iron, while the other form is carbonate of iron (siderite). In either case the ore is calcined for several hours at red heat, which process changes the hydrated oxide as well as the carbonate to the sesquioxide. The highest percentage of sesquioxide produced from the siderite form of ore does not exceed 45 per cent. while it mostly averages 38 per cent. sesquioxide of iron (Fe_2O_3) only. The metallic brown prepared from the natural hydrated ore reaches as high as 72 per cent. of Fe_2O_3, but many prefer the former grade, especially for

making brown roof paints in the liquid form, its specific gravity being much lighter, keeping in better suspension in the paint. As is well known, metallic or mineral brown paint is specified by a number of railroad corporations as well as by the Army and Navy Departments and the various U. S. Lighthouse Districts, and the Isthmian Canal Commission have purchased millions of pounds by contract. While most of this brown is used for painting wooden surfaces, such as freight cars and freight stations, way houses, bridges, etc., it is a fact long established that a well-prepared metallic brown, no matter what it may contain in its composition as to the percentage of sesquioxide of iron, and if free from any appreciable traces of sulphur and ground in and thinned with pure linseed oil and a minimum of good drier, makes a good protective paint for iron or steel, as well as for wood. The government service specifications are especially emphatic in barring out any metallic brown deliveries that show in the pigment sulphur in any form that would equal more than 2 per cent. of sulphuric anhydride. Mineral or metallic brown should be ground very fine in the dry state, especially when the paste or semi-paste is to stand the test for fineness prescribed by government and railroad specifications, otherwise the grinding will not only become expensive, but it is difficult to maintain the standard shade on account of the heat generated in the mills, and by running the paste through very close stones it is liable to become gummy and will not break up so readily on mixing, a point on which much stress is laid.

Iron or steel mills are not adapted for grinding mineral browns nor can roller mills be recommended. Buhr stone mills of 24 to 30-inch diameter, with hoppers of good capacity and a good grinding surface, are best for

these pigments. For a heavy paste 78 per cent. dry pigment and 22 per cent. raw linseed oil is required to grind the metallic brown of light gravity, while for the heavy gravity brown, that runs from 60 to 70 per cent. in sesquioxide of iron, 20 per cent. oil to 80 per cent. pigment will be sufficient. A gallon of 231 cubic inches of the former will weigh 17 to 17¼ pounds, while of the latter grinding a gallon will weigh 18 pounds net. When it is specified that the brown shall not contain in the pigment over 40 per cent. of sesquioxide of iron and that the consistency be that of a semi-paste, showing approximately 75 per cent. of dry pigment and 25 per cent. raw linseed oil, a gallon of this semi-paste should weigh 15½ pounds net.

The practice of mixing the dry mineral or metallic brown by hand in the oil should be discouraged by the manufacturers of the dry pigment as well as by color grinders and their representatives, because many roofers simply use cheap mineral oil or even kerosene for mixing the pigment for painting tin roofs, thus causing the metal to corrode very rapidly, while if the pigment was properly enveloped in linseed oil the paint would give protection for years. There are offered to the paint market some earths as mineral or metallic browns that contain very little oxide of iron and are no better than ordinary colored clay or slag, the use of which should be carefully avoided by reputable manufacturers.

Italian and American Sienna Earths.

We are placing sienna earths in the group of brown pigments for the reason that they really differ vastly from yellow ochers in both tone, strength and chemical constituents, at least so far as the percentages of the latter are concerned.

Sienna earth, or natural sienna, so called after a town in Italy, not very far from Rome in the hills, where underneath the top layers of earth over the rocks the material was at one time found in abundance, is a yellow pigment with a more or less brownish red tinge in the solid and a more or less yellowish undertone. It differs from the best French yellow ocher by having a much deeper color, more than twice the tinting power, containing only two-fifths as much silica, only one-third as much alumina and from two and one-half to three times as much ferric oxide, and in addition to this from one to one and one-half per cent. of manganese oxide, to the presence of which is due the difference in color. The localities where sienna earth is found are not confined to the original one near the town of Siena, but all through Tuscany and in the Hartz Mountains of Germany, earth of similar quality is found. In the United States in Pennsylvania deposits of sienna earths are found, and in the mountain ranges of Virginia good, rich deposits have been developed. The present commercial offerings to the trade vary from very strong decided yellow toned earths to those of a decidedly russet tone. Up to twenty years ago no painter would have purchased the yellow raw siennas that are great favorites with some painters to-day, because of the strong yellow tints produced with white, thereby displacing yellow ochers to quite an extent. The raw sienna in oil on the market up to that time was the kind that when ground fine in oil showed up with excellent transparency and when used for staining white lead made an excellent oak graining ground without any other addition. A certain old-established firm of oxide and color makers discovered a mine of earth in Virginia, which they developed and found to be very high in oxide

of iron with all the other constituents of sienna in combination. At that time the movement for pure oil colors of exceptional strength was at its height and the firm in question floated, dried and powdered part of the earth, while they calcined another part, thus obtaining very strong raw and burnt sienna that when ground fine in oil, put all the Italian sienna in the shade for tinting power, because while the latter required more than its own weight of oil for grinding, these new products only required 40 per cent. of oil for the raw and 35 per cent. for the burnt. The concern in question, by diligent advertising among color grinders, sold so much of the product that the best veins in the mines were exhausted in a very few years, and later mining did not produce the strong products. Still it was the start among the consumers of oil colors to favor the raw sienna, producing the yellow tint with white. Ordinary domestic siennas, that grind well in 35 per cent. oil to 65 per cent. of pigment and resemble the tone of the old-fashioned Italian goods, are rather dull, somewhat gritty and lack tinting power. The following will give a good idea of an average Italian raw sienna of fair quality in comparison with average domestic product:—

ITALIAN SIENNA, RAW

	Per cent.
Combined water (H_2O)	9.67
Ferric oxide (Fe_2O_3)	53.83
Alumina (Al_2O_3)	5.85
Silica (SiO_2)	28.25
Calcium carbonate ($CaCo_3$)	1.12
Manganese (MnO_2)	1.28
Total	100.00

AMERICAN SIENNA, RAW.

	Per cent.
Combined water (H_2O)	10.24
Ferric oxide (Fe_2O_3)	32.13
Alumina (Al_2O_3)	15.60
Silica (SiO_2)	38.10
Calcium carbonate ($CaCo_3$)	2.17
Manganese (MnO_2)	1.76
Total	100.00

All the hygroscopic moisture had been removed before the analyses were made. The siennas of which analysis is shown here required 52 per cent. raw oil to 48 per cent. pigment by weight for the Italian and 36 per cent. raw oil to 64 per cent. pigment in the case of the American for mixing and grinding, producing a good buttery paste in each case.

Discriminating painters will not take kindly to the native sienna, unless it is of the exceptional strength referred to above, and even then they will prefer the old fashioned Italian material, when it comes to graining in oil or distemper, where the tone is of importance. The same applies when it comes to a selection of raw sienna for artists' tube color, while for grinding in japan the softer Italian grades are also preferred. Artists will prefer the browner surface tone in raw sienna and the nearer it comes in its general tone and the tint produced in admixture with white to the raw or natural sienna offered by Winsor and Newton, the better it is liked by them. Raw Italian sienna of that grade requires more than its own weight of oil for mixing and grinding, and will run about 40 of pigment to 60 of oil by weight. Car painters, who use raw sienna in japan for

graining purposes on quick jobs also prefer this type, as it works more easily and is not so apt to sag or run, as those that carry an extra high percentage of oxide of iron. It seems rather queer, but is an established fact, that yellow ochers and siennas, that show exceptionally high percentages of iron oxide do not work as well under the brush as those of a lower percentage. Presumably this is due to a lack in the portion of gangue required to give the characteristic properties desirable in each. While in a mixed paint, such voids can be filled, it is not feasible to effect this in an oil color for several reasons. First of all, any experienced analyst would discover the deception and brand it as an adulteration, and secondly the addition so made would not produce the effect as completely as is done by nature. Raw sienna is, as noted above, used as a water color, ground to a fine paste without size, by grainers and in distemper work, and 50 pounds pigment mixed with 60 to 65 pounds of water will produce 100 pounds of finished paste. It is put up like all distemper colors, preferably in well sealed glass jars, because otherwise it will soon become dry and hard, on account of the evaporation of the water.

Mixing and Grinding Burnt Sienna.

Burnt sienna, whether it be the Italian, the domestic or from any other source, is the product obtained by calcining or roasting the natural or raw sienna earth, at moderate red heat. This process drives off the combined water in the raw earth to a greater or lesser extent, but hardly ever fully, as to do so would give a very dark brown product, while the brighter and redder toned siennas are much preferred and command the higher price. The brightness of tone does not depend

entirely upon the temperature and length of time used in calcining, but to a greater extent upon the quality of the natural earth. The so-called red fire burnt siennas, so highly valued for their brilliancy of tone and richness of tint, that were imported years ago from Italian sources, are hardly met with now, excepting in rare instances, due, it is said, to the mines being exhausted, which may be partly true, but it is also a matter of fact that the average manufacturer will not pay the price asked, when the consumers themselves look more for tinting strength, than for transparency and brilliancy of tone. What has been stated as to the history of raw sienna applies to the burnt material equally as well, and some of the burnt siennas of exceptionally strong staining power show as high as 76 or more per cent. sesquioxide of iron. As a matter of interest we give the result of the analyses of a good average burnt sienna of Italian and American origin:—

	Italian. per cent.	American. per cent.
Combined water, H_2O	2.96	2.12
Ferric oxide, Fe_2O_3	57.23	38.18
Alumina, Al_2O_3	6.40	16.37
Silica, SiO_2	31.03	39.12
Calcium carbonate, $CaCo_3$	1.30	2.56
Manganese MnO_2	1.08	1.65
Totals	100.00	100.00

As in the case of the raw siennas, the hygroscopic moisture had been removed from the samples before the analyses were made. The practical grinding trial of these two lots, after drying the material on steam heated pans for several days at temperatures averaging 135° F. required 46 pounds of raw linseed oil to 54 pounds pigment in the case of the Italian and 34 pounds of the same oil to 66 pounds pigment for the American sienna,

resulting in a buttery paste of lighter bulk in the former, than was the case with the latter, which resembled more the compactness of burnt ocher. Burnt sienna, that is largely used, ground fine in oil for grainers, as well as for tinting purposes, and even in composite colors, such as olive greens and some bronze greens, as well as in pigment stains for imitating cherry and mahogany, is at its best when of a somewhat deep red, but not brown overtone, with good transparency, which is most desirable for stains, as well as for graining work. The usual run of American sienna will not answer for that purpose, no matter how closely it resembles the Italian importations. When grinding burnt sienna in oil or in japan, excessive heating of the mills tends to deepen the color and in many instances make it appear richer, but it also makes the staining power more or less deficient. The best mills for grinding burnt sienna are those equipped with buhr stones of 20 to 24 inches diameter, and these should not make over 60 revolutions per minute. The temperature of the color in oil should at no time exceed 150° F., otherwise the product will be grainy on cooling, especially if the pigment contained some hygroscopic moisture on mixing with the oil. For grinding burnt sienna in japan, 20-inch water cooled mills are best, and if the pigment consists of finely powdered sienna, the grinding stones may be of the esopus variety. In grinding sienna in japan, the less heat is developed in the milling the less the loss of volatile matter in the japan and the less tendency of the finished product to be gummy or tending to liver.

The average requirements for mixing and grinding good qualities of Italian burnt sienna in oil may be figured at equal parts by weight of pigment and raw

linseed oil, while for the japan color a fairly safe average would be a mixing of 44 pounds of pigments and 58 pounds color grinding japan, yielding 100 pounds finished product, balance being lost through evaporation of some of the turpentine in the japan and the hardening of some of the color on scrapers and flange of running stone, as well as in the hopper.

On lots smaller than 100 pounds in one batch, 10 per cent. loss will not be too much to figure on. As mentioned in the case of raw sienna for artists' tubes, only the old time standard of material should be selected in burnt sienna as well and the more brilliant the overtone of the pigment, the more favorably the color will be received by the user. In grinding burnt sienna for the artist, extreme care for obtaining the highest degree of fineness and absence of all grit must be exercised, and burnt sienna of that character will require not less than 55 to 60 pounds of poppyseed oil, and 40 to 45 at most of pigment. For burnt sienna in distemper, a grade of rich, deep color, not too high in oxide of iron, should be selected, so that it may work well for the grainer as well as for the fresco artist. Must be free from grit and ground fine in water, and figures may be based on 50 pounds pigment and 65 pounds water, which batch should yield 100 pounds paste as it comes from the mill.

Before closing our remarks on sienna, we may state that the specifications of the various service departments of the United States Government bar out any sienna, raw or burnt, that is not equal to the best Italian grade on the market or that contains more than 5 per cent. of lime in any form.

Selecting, Mixing and Grinding Umber.

Umber earth, as it is called in its native state, is found in many localities, but the best undoubtedly comes from the island of Cyprus. Other inferior qualities are found in England, Wales, France and the United States. That found in Germany is known as Cologne earth. The umbers, both raw and burnt, that are imported into this country nearly all come through Italian merchants, some of whom bring them over to their country from Cyprus, assort them into grades and calcine or burn the largest portion in their own factories. Livorno (Leghorn) is the port from whence most all of the Italian ochers, siennas and umbers, along with pumice stone, talc, tripoli, etc., are exported, although there are a few houses in Rome in this exportation business. Of late years some Greek merchants have attempted to export crude umber into the United States in a large way, attempting to dispose of large cargoes here, but the writer has not heard that the scheme was really successful. The reason for this failure can be attributed to the fact that in the first place, the crude material requires careful sorting, and that a great deal of useless ballast in moisture and waste material would have to be freighted, and, above all, there is no established factory in this country where sorting and assembling the material could be done at as low a cost as it can be done in Italy at establishments equipped for this very purpose. The importation of umber, raw and burnt, in lump form, has fallen off to a considerable extent, but to a greater degree in the raw or crude state. It used to be the practice of a few of the largest color grinding establishments in this country to import raw umber earth as well as burnt umber in

pieces and in lump form, and drying out the mining moisture in the raw earths in kilns or on steam pans, put the pieces or lumps through crushers and then pulverize the same on dry color mills of 30 to 42-inch diameter buhr stones. This, of course, meant considerable expense, when the loss in drying and the cost thereof, as well as the handling and grinding was figured, but even when there was as high as from 23 to 32 per cent. mining moisture, the total cost of the powdered raw umber was considerably below the price charged for the imported powdered goods, and the product was far more uniform, and still lower in price or cost than was charged by some of the jobbing houses or importers for similar qualities. The difference can be accounted for in several ways. There was a certain percentage of mining moisture allowed by the exporter on the other side, the tariff on unwrought earth was very low in comparison with the finished dry umber in powdered form, and there was neither the middleman's profit nor warehouse or storage charges to be paid the importer. Then again, the goods coming in very large quantities by sailing vessel or tramp steamer, the freight was lower, also, than the usual rate. This system of importing the material in the lump form could, as a matter of expediency, be carried on only by very large consumers, who were in possession of the dry color grinding apparatus and the storage room, as well as wharfage or railroad siding facilities. However, some of the few concerns that still adhered to this practice, have lately abandoned it and are purchasing the powdered goods instead.

Selections and Analysis of Raw Umber.

The best quality of Cyprus raw umber has a peculiar greenish cast, which we usually term olive, and its color

is due to ferric oxide of iron and quite a large percentage of dioxide of manganese, to which latter is also due its good drying quality when ground in linseed oil. Some specimens have a somewhat dull reddish or yellowish cast. These, however, produce a poor tint with white. The olive toned raw umber, makes a much warmer tint and is especially favored by artists and decorators. Raw Cyprus umber consists essentially of hydrated ferric oxide of iron, manganese dioxide and silica and silicate of alumina, with lime in small percentage and minute portions of phosphoric acid. A very good sample of Cyprus raw umber, after drying out all the hygroscopic moisture, gave the following analysis:—Combined water, 8.84 per cent.; ferric oxide, Fe_2O_3, 51.20 per cent.; manganese dioxide, MnO_2, 13.16 per cent.; carbonate of lime, $CaCo_3$, 2.12 per cent.; alumina, Al_2O_3, 3.18 per cent.; silica, SiO_2, 21.27 per cent.; phosphoric acid, P_2O_5, 0.23 per cent. Total, 100 per cent.

Against this we will mention the analysis of a sample of bone dry American raw umber, which was considered the best specimen of that class found in a number of years:—Combined water, 10.85 per cent.; ferric oxide, Fe_2O_3, 20.13 per cent.; manganese dioxide, MnO_2, 9.26 per cent.; carbonate of lime, $CaCO_3$, 6.12 per cent.; alumina, Al_2O_3, 13.37 per cent.; silica, SiO_2, 27.56 per cent.; calcium sulphate (gypsum), $CaCO_4$, 2.71 per cent. Total, 100 per cent.

This specimen of American raw umber when rubbed out in oil had a yellowish brown tone, as against the olive of the Cyprus umber and lacked the semi-transparency of the latter, as well as its richness. Had a dull appearance in comparison, that a practical painter

would describe as having "no life." In testing the staining power or strength for staining white, the Cyprus specimen gave a strong, warm, brownish tint with a tinge of green, while the American umber produced with the same white a weak, cold stone gray.

Grinding Raw Umber in Various Vehicles.

As will be seen from the chemical analysis of raw umber, it contains quite a high percentage of manganese dioxide, which constituent exerts a strong drying influence on linseed oil, even when it is not incorporated with the oil by heat. Umber, whether raw or burnt, that is put up in containers for the trade where it is liable to be held in storage for long periods, should not be mixed and ground in boiled linseed oil. Not only on account of its liability to form skins, but for the reason that when used in large portions with white to obtain certain effects on exterior painting, it would if not used judiciously by omitting much of the dryers, exert the same bad influence on the life of the paint, as if an excess of dryer had been used. If the dry pigment is in fine powder and of soft texture, it is best ground on 20 or 24-inch esopus stone mills, running at no higher speed than that suggested for grinding sienna, as too high a temperature in the mill is very apt to darken its natural color. If it is harsh in texture, buhr stones are required to grind it down to proper fineness without needing many runs. Raw Turkey umber of good average quality will require its own weight of raw linseed oil to produce a smooth paste, while American raw umber usually requires thirty-five pounds of raw oil to sixty-five pounds pigment for one hundred pounds of paste.

For use as a japan or coach color, none but the best grade of raw Turkey umber of the olive hue should be selected, and it is best to temper the very quick drying of the color somewhat by the addition of raw linseed oil, this addition depending upon the strength of the japan. The usual proportions being 46 per cent. by weight of pigment, 50 per cent. japan and 4 per cent. oil.

For artists' tube color only the very warmest olive toned raw Turkey umber should be selected and ground very fine in poppyseed oil, on stone mills of small diameter, not permitting too high a temperature, so as not to dull the natural tone. Here as in the ordinary oil color, oil and pigment will be about equal in weight. While raw umber is not used to any great extent ground in water, it is all the same necessary to have it on the list of distemper colors, as it is desirable for producing certain effects in fresco or distemper painting. To produce one hundred pounds of finished paste will require a mixing of sixty pounds water with fifty pounds pigment, the loss being caused by the evaporation of the water during the grinding process.

Selecting, Mixing and Grinding Burnt Umber.

What we know as burnt Turkey umber is the Cyprus raw umber, burnt or calcined in the lump form and is imported into this country in this as well as in the powdered form. It runs from light reddish brown to a violet brown, its tone depending upon the nature of the raw material it is calcined from. The roasting or calcination drives off some of the combined water in the raw material and imparts a warmer tone, deeper color and more translucency to the pigment.

It is scarcely worth while to dwell in detail on the chemical constituents of burnt umber, as they are practically the same as in the raw pigment, with the exception that the combined water being present in a reduced percentage, the other constituents will show a relatively higher percentage. Burnt Turkey umber with a reddish brown tone makes a stronger stainer, but the pigment with a neutral tone that leans, when rubbed up in oil, to the olive with a tinge of the violet and produces when used with white a tint that has a suspicion of lavender-gray with its drab effect, is far preferable to the almost terra cotta brown tint produced by some of the reddish toned burnt umbers. The principal feature is a warm, rich brown in the solid color, because this is best for the use of grainers and stainers, where most of the color is really used. American burnt umbers, though there are some very good specimens offered, are unfit for these purposes, being too opaque and not rich enough in color. Nor will it carry enough oil to serve well as a stain. Burnt Turkey umber should be ground on similar mills and at same speed as mentioned for sienna, but the temperature need not be watched as carefully, as the tone is not so liable to suffer from excessive heat. The average percentage of raw linseed oil and pigment may be set down at forty-seven of the former and fifty-three of the latter, while American burnt umber may be mixed and ground in the proportion of 60 per cent. pigment to 40 per cent. oil, if of good selection. For grinding burnt umber in japan and for artists' tubes, the same rule applies as for raw umber; while for distemper and fresco work, burnt umber is an important part in the list, being used to a very great extent, especially for graining in distemper. It may

be mentioned that as a rule burnt umber is not as difficult to grind fine as the raw pigment and buhr mills are not absolutely necessary.

The Use of Sepia as a Water Color.

Sepia scarcely interests color grinders in general, as it is mostly used as a water or moist color. It is made from the ink bag of the cuttle fish, the gland so-called, in which this fish secretes the blackish brown liquor for defensive purposes. These bags can be bought in the dry state and boiled in a solution of soda, that dissolves the color, but not the bag. The liquor is then filtered and neutralized with hydrochloric acid, which throws down a precipitate that is washed and dried. Sepia is of a color between asphaltum and Vandyke brown, very strong, and while it will mix with oil, it is hardly ever so used. Still it is almost indispensable on the palette of the artist for water color painting, but is not used in distemper work.

Selection, Grinding and Use of Vandyke Brown.

Most of the so-called Vandyke browns imported into the United States are known on the other side as Cassel earth or Cologne brown. They are of organic origin, peat mixed by nature with more or less earthy matter. They have a rich warm tone, generally much darker than the darkest shades of burnt umber, although they vary somewhat in depth and are assorted light, medium and dark. Vandyke brown is not permanent enough when used for tinting, although with white it produces a peculiar lavender gray tint. But it is almost indispensable for graining in oil or water and for staining

furniture. Oilcloth makers also use it ground in oil to a great extent, but it is a very slow drying pigment and should be well dried to expel the hygroscopic water before mixing and grinding in oil. Requires to be ground in strong boiled oil or at least the addition of strong drier. Being very light in specific gravity, about 55 pounds of pigment and 45 pounds of oil will make a fair paste, and a 24-inch mill will be the best size for grinding in large batches. When the paste is required to be rather stiff, an iron mill is better adapted than than stone mills. When grinding in japan, a very quick drying coach japan is the best vehicle. It should be also on the distemper color list, as it is used quite frequently for graining, 50 pounds pigment and 60 pounds water will produce one hundred pounds finished product.

CHAPTER X.

MIXING AND GRINDING GREEN PIGMENTS.

In green pigments there is quite a large field and greens really form a most interesting part of the general subject of color grinding, not only in oil for the trade in general, but also for the coach painter and the artist.

Foremost in the line of greens is what we call chrome green, which, however, is known on the other side as Brunswick or royal green, an intimate mixture of chrome yellow and Prussian blue, while what is known to English and Continental painters as chrome green, must be designated here as chromium oxide green or oxide of chromium green. In the oil color lists will be found such names as bronze, bottle, Quaker green, also Paris green and verdigris, and any number of fancy names for green in oil, which are, however, chrome greens, sold under proprietary brands of varying compositions, none of them being mixtures of pure chrome yellow and pure Prussian blue, but more or less extended with barytes or blanc fixe, china clay and sometimes gypsum. In the coach color list we find these mixed chrome greens under such brands as chrome green, brilliant green, coach painters' green, milori green, in shades from extra light to extra dark, and the proprietary names or brands are legion. Then there are such as emerald or Paris green for ornamental and striping work and ultramarine green. Aside from these are popular brands of composite greens, such as Brewster, bronze, Merrimac, royal, Russian, Siberian green, in which green always predominates, but in which black forms an

important part as well, aside from small percentages of other colors. In the lists of artists' colors will be found a fine grade of Paris green, branded as a rule emerald green or Schweinfurt green, while oxide of chromium green will be found under this name or emeraude green, sometimes also labeled Guignet's green, while green earth is branded terre verte or Verona green, also sap green and ultramarine green. Mountain green (malachite) is used very seldom by artists for oil painting. Green cinnabar consists of various mixtures of Prussian blue with zinc yellow or strontium or Guignet's green with a very small portion of strontium or barium yellow. There is very little call for greens in distemper in this country, although some color grinders list bronze green, emerald green, chrome green, terre verte or Verona green, ultramarine green and verte emeraude (oxide of chromium green).

Commercial Chrome Green in Oil.

While government service specifications, when sending proposals for chrome green to manufacturers, call for an intimate mixture of at least 98 per cent. chrome yellow and Prussian blue, permitting the presence of not over 10 per cent. lead sulphate, the color consuming trade in general has very little use for a green of that composition for many reasons, although on some occasions chemically pure chrome green is called for, as will be seen below. In these instances, however, there is no restriction as to the percentage of lead sulphate present and the color grinder, when purchasing dry chrome green of chemical purity, will select those of the greatest staining power at equal price. If lead sulphate is present in excess, this will show up in the testing of

tinctorial strength. As a matter of course, he will also consider richness of tone, softness of texture and oil absorption, as no matter how high the price of oil may go, it will hardly ever reach the price of chemically pure chrome green, pound for pound.

Some twenty or thirty years ago the trade did not think of purchasing any so-called chrome green that did not carry in its pigment portion anywhere from 80 to 90 per cent. by weight of barytes, and some proprietary brands of this green that carried in the pigment as much as 25 per cent. coloring matter found a ready market at fair prices. The chemically pure green being so very opaque and of such great tinctoral power, it was deemed unwise and wasting money not to extend the pigment with barytes to the extent mentioned. Later on, when the crusade for pure colors was under way, the paint and color grinders, by common consent, adopted 25 per cent. color and 75 per cent. barytes as a standard for a medium shade of chrome green, with a slight variation for the deeper shades. In those days the Bureau of Engraving and Printing at Washington bought their annual supply of chrome green for plate ink of that composition. To-day this branch of the government service purchases chrome yellow of the pale lemon shade and Prussian blue, doing the mixing themselves and adding base white or barytes, according to a formula that is a department secret. The most prominent manufacturers of wire cloth at that time purchased the green for painting the cloth ground in oil, using many tons during each season of a blue toned chrome green of the 25 per cent. pure color and 75 per cent. barytes type. They found, however, much loss by settling in the dipping tanks and changed to 50 per

cent. pure color and 50 per cent. clay in the pigment and still later found that the chemically pure green was cheapest for their use in the end. About five or six years since the wire cloth makers agreed to abandon the use of green on wire cloth and to print the cloth in black only. That green wire cloth was less in demand may be accounted for by the fact that some manufacturers used greens for painting the cloth that were not even ground in paste form, but dry green job lots, simply mixed with inferior thinners. The consequence as a rule was, that the cloth, when in the storerooms of jobbers and dealers but a short time, lost its coating of green paint by flaking off at the slightest touch. Numerous have been the attempts of color makers to furnish chrome greens to grinders on other bases than barytes, but all of them have proven futile, so far as their use for the painter was concerned, because painters, especially house painters, want a green that has a tooth and filling properties, both of which are furnished by fine barytes. So long as chrome green in oil, when properly thinned for exterior work, as trimmings, blinds, etc., covers fairly well in one coat over a lead colored primer, it is the material desired by that class of trade.

The Grinding of Chrome Green in Oil

for the trade is still done by many color grinders in the same manner as it was in the long ago, that is, they purchase various shades of chrome green that are extended by the color maker with barytes, either in the precipitation tank or on a mill by mixing barytes with dry chrome green that has probably been stretched or extended in the wet way, the additional barytes being

added simply to meet lower prices. Trial mixings and grindings made years ago by several firms to produce commercial or proprietary brands of chrome green in oil by mixing certain portions of chemically pure green, barytes and oil, instead of mixing and grinding the dry extended green in oil, failed, as it was found, on long standing, that the grinding was not homogeneous, the color on opening containers set aside for six months or more, floating on top, while the barytes had caked in hard sediment in the bottom and was found almost devoid of color. Whether this was due to the coarse nature of the barytes or to the use of a poorly made chemically pure green, was difficult to determine. We believe both factors helped to make the scheme a failure. Yet there was one color manufacturer in the country who conceived and carried out this idea, not only in greens, but in other strong colors, and who thus simplified his manufacturing methods and grew immensely rich thereby. Instead of having a dozen or more lots of greens of various compositions, he got along with a stock of three or at most four shades of chemically pure chrome greens, which he had ground fine in oil, then added as his trade required it, a certain percentage of fine floated barytes and sufficient additional oil, giving this mixture one final run through the mill, thus obtaining a smooth paste that was liked by the trade and for which he obtained better prices than most color grinders who spent more money for manipulating a lot of barytes green through the mills. His wisdom was in keeping a very large stock of one grade of barytes only and that of the whitest and finest floated grade, while other color grinders and color makers proved penny wise and pound foolish by purchasing off colored and coarse barytes, thinking that anything was good enough in a color like

green in their desire to save a few dollars per ton. Furthermore, the color grinder referred to, by following his method was always assured of uniformity of the goods, a feature that is doubtful when the extended dry green is purchased or made in the same factory where it is afterwards ground in oil. The failure above referred to strengthened the belief on the part of some color grinders and color makers that in order to make an extended green that would not separate after being ground in oil, it was necessary to make it in the color maker's tub, so as to color or rather fasten the color on the barytes, which is or at least appears to be an unconfirmed theory, as a mixture of Prussian blue and chrome yellow cannot act as a dye upon a substance like barytes. It is simply a mechanical mixture in either case, no matter how it is done.

For this reason, if the color grinder has not any special object in view, he can, instead of carrying a stock of extended chrome greens, minimize it by purchasing chemically pure green of such shades as he needs and mix such portions by weight of these and fine, floated barytes with the oil and grind it, thus always being fairly certain of a uniform product so long as the chemically pure green is up to standard, which he can determine in the usual way, testing for color, tone and tinting strength. The constituents of chrome green being Prussian blue and chrome yellow, the mills on which they are to be ground should be run at moderate speed and soft or esopus mill stones are best for grinding these greens, the diameter of the mill should be commensurate to the quantity of the batch or to suit the demand. Twenty-four-inch mills are probably best, but thirty-inch mills are not too large if run at a speed of not over

thirty-six or forty revolutions per minute. When a batch of chrome green is being mixed, it should be so arranged that the mixing of oil and pigment is complete before machinery is stopped for a time, because imperfect mixings have been known to take fire when dry green was lying on some linseed oil. As to the percentage of oil required for mixing and grinding these greens for the trade, we will give the following figures that are subject to some variations, according to the gravity of the chemically pure green and the nature of the barytes. Chemically pure green that contains more lead sulphate than others, will require less oil for grinding and the deeper the shade of green, the greater the oil absorption. Assuming that a commercial chrome green is wanted, that is to consist of 25 per cent. pure color in the pigment and is to be of a medium shade, it will require twenty-one pounds chemically pure chrome green, medium, dry; sixty-three pounds floated barytes and sixteen pounds raw linseed oil to produce one hundred pounds paste. To turn out one hundred pounds of paste of a 20 per cent. green of similar shade, will require seventeen pounds chemically pure chrome green, medium, dry; sixty-eight pounds floated barytes and fifteen pounds raw linseed oil, but the former should turn out a trifle stouter than the latter. There are chrome greens in oil on the market that contain only 10 per cent. pure color in the pigment and some even less. A medium shade of this type would consist of about nine pounds chemically pure chrome green, medium dry; eighty-one pounds barytes and ten pounds of oil, not always necessarily pure linseed oil. A reputable color grinder will hardly ever place his name on the label of goods of this type.

The proportions of pigment and oil here given, as above noted, are for greens of medium shade, but for greens of extra deep shade these percentages will differ to quite an extent. For instance, a 25 per cent. green of extra deep shade would be made up of twenty pounds dry pigment, sixty pounds barytes and twenty pounds oil for one hundred pounds paste, while a 10 per cent. green of that shade would require eight and three-fourths pounds dry pigment, seventy-eight and one-fourth pounds barytes and thirteen pounds oil for one hundred pounds paste. Chrome greens of the latter type were extensively sold to wagon and implement manufacturers, dry and in paste form. Since the consolidation of the agricultural implement and wagon making interests, very little green of that composition is ever sold any longer in paste form to those trades, as they purchase their requirements in the color line in the dry form and do their own grinding. Chemically pure chrome greens are manufactured by color makers in two forms, the nitrate of lead greens and the acetate of lead (sugar of lead) greens. The last named are usually stronger in staining power and of yellowish undertone, while the former, which are higher in price and believed to be more permanent, are of the blueish type. These seem to be rapidly going out of the market and are used only for special brands in oil on account of the cost. The difference is in the chrome yellow used for the mixing with the Prussian blue, one being made with nitrate of lead yellow, the other with acetate of lead yellow, that made with the latter being lowest in cost of production. To grind chemically pure green in oil in paste form requires on the average for the medium shade seventy pounds dry color and thirty pounds linseed oil, for light shades seventy-two pounds dry color and twen-

ty-eight pounds oil, for deep shade sixty-eight pounds color and thirty-two pounds oil, and for extra deep shade sixty-four to sixty-six pounds color and thirty-four to thirty-six pounds oil to form a paste of good consistency, that will break up readily on thinning for use. But as stated above, the demand for green of this character by the general trade is limited and not many jobbers or dealers will carry it in stock. However, the color grinder who makes a full line of paints in liquid form, also will find the chemically pure greens in paste form of decided advantage for many purposes where the heavy gravity of barytes is objectionable, as he can use such paste green as a base for stains or in composite greens. We shall speak of this in detail under the caption of paint making later on.

Chrome Greens in Japan.

In this line we find the chrome greens, when so listed of the same type, as the 25 per cent. greens in oil, while those listed as coach painters' green are usually stronger in color, running as high as 33 to 40 per cent. actual color and in some rare instances as high as 50 per cent. Some proprietary brands, such as brilliant green, and a few others with fancy names, such as full strength green, are chemically pure, while milori green is of varying composition, anywhere from 50 per cent. color to pure. This latter green should be a peculiarly rich shade of green to deserve that name, but such is not always the case. Chrome green for coach and car work is best ground in gold size japan, because the brown color of ordinary color grinding japan is apt to have an effect on the tone of the green in drying out on the surface and the subsequent coats of varnish cannot overcome this,

nor can a coat of color and varnish remedy such defect. When figuring on the proportions of pigment and japan necessary for grinding these greens in japan, it is necessary to allow for the loss by evaporation of the volatile portion of the japan, which sometimes is quite large. Assuming that a deep shade of chemically pure chrome green, which, if ground in oil, requires thirty-two pounds liquid to sixty-eight pounds of dry color, it will require forty pounds gold size japan to from sixty-three to sixty-four pounds color to produce one hundred pounds of the finished product, which must be ground on a water cooled esopus stone mill of not over twenty-inch. diameter, with a speed of not over thirty-six to forty revolutions per minute, as the temperature of the color should never exceed 110° F. Chrome greens are very delicate and easily spoiled by overheating. If water cooled stone mills are not part of the apparatus at the disposal of the color grinder, a water cooled iron mill of sixteen or eighteen-inch diameter will do the work, provided the grinding surface is not too dull.

This applies equally to the extended chrome greens in japan, a 25 per cent. green requiring, if of medium shade, eighty pounds pigment and twenty-three pounds of gold size japan to produce one hundred pounds finished color. Here the color grinder will find it of advantage to make two operations, which may seem a trifle out of the way, but will make a better product at less cost for power and wear on the mills. Instead of mixing the dry color and barytes in the gold size and giving the mixture several runs, the chemically pure green is first ground fine or almost fine in the japan and the barytes added to the product on the last run with the additional thinners, if any be required. For the 25 per cent. green of

medium shade as above, grind twenty pounds chemically pure green, in say twelve pounds gold size japan, and add to this on last run sixty pounds barytes and ten pounds more of gold size japan. This should produce 100 pounds of quick drying, medium chrome green, that when thinned with pure spirits of turpentine, will cover very well on coach or fine wagon gears or bodies over the proper ground work, even in one coat. Many so-called express greens are of this type when a green of blueish tone is used.

When a very deep shade of chrome green in japan is wanted in this commercial quality, less pigment and more gold size japan is required, same as is the case in an oil color green. For instance the shade is extra dark, grind nineteen pounds of the chemically pure green of that shade in say fourteen pounds of gold size japan to standard fineness, add fifty-seven pounds dry barytes and twelve pounds more of gold size japan, run the mixture through the mill once or twice more and the product should be 100 pounds quick drying, extra deep chrome green. It is self-evident that when this method of mixing and grinding is adopted the barytes must be of impalpable fineness and soft texture, and as blanc fixe (precipitated) barytes is not usually in fine powder, even when fairly soft in texture blanc fixe must be mixed with the dry green at the very start and both ground together in gold size japan to a finish. Taking for granted that a color grinder desires to place upon the market an extended chrome green of rather light specific gravity that will spread over more surface than the ordinary commercial brand of coach painters' green, and yet be lower in cost than a chemically pure chrome green, it is open to him to use blanc fixe in place of the

natural floated barytes. Blanc fixe can be bought in the dry powder, but it is well to determine carefully that it is really dry, and the same is also necessary with the green before mixing with gold size japan, as the latter will not work well with moist or damp pigments of any kind. As first class blanc fixe absorbs nearly as much japan as would a light shade of chemically pure chrome green, the extra expense of its use is but little more than the difference in cost between it and the chemically pure green from the color grinder's standpoint. However, to the consumer who uses the green not for tinting, but for covering surfaces solidly, the price and the working properties of a green extended with blanc fixe in comparison with the chemically pure green has its meaning. Take as an example, a green composed in its pigment portion of 40 per cent. by weight of color and 60 per cent. by weight of blanc fixe, and figuring on an extra deep shade, the difference in the cost of the dry pigment alone is in favor of the extended green to the extent of from nine to ten cents per pound at present market rates. A green in japan of this composition will require twenty-six pounds chemically pure green, extra deep dry, thirty-nine pounds blanc fixe dry and thirty-eight pounds gold size japan for 100 pounds finished paste, and the bulk of the color will be very nearly as great as that of chemically pure green in japan. The lighter the shade the less japan will be required for mixing and grinding and the bulk of the color correspondingly less.

While chrome green extended with blanc fixe is not so apt to settle out when thinned for dipping as is often the case for small metal ware that is baked, it is always best to grind chemically pure green in varnish specially adopted for baking, so that when the base so ground is

thinned with more varnish to the consistency for dipping, there will be no sediment, which would be apt to give trouble. For work of this kind chemically pure greens are none too strong, as the less color that is used, the better the working properties.

While chrome greens are to be found in the lists of tube colors, they are not used by artists of renown for picture painting, but are made use of by amateurs and professional sign writers, the latter using the large size tubes for the sake of convenience. It would be wasteful to mix and grind such greens in expensive poppyseed oil, as bleached or refined linseed oil will serve the purpose very well. The only difference that may be required is to grind the greens of whatever composition may be selected for the list to the utmost degree of fineness. Another point is, that chrome greens to be put up in tubes, should be held stouter than the commercial chrome greens that are put up in tin cans, so that when the color is squeezed out of collapsible tubes, the pigment is not so likely to separate from the oil. It does not as a rule require as much refined oil for the grinding of chrome green as it does of raw linseed oil, because refined linseed oil is more limpid. This is due to the removal in the refining process of mucilaginous matter and impurities, commonly known as linseed oil foots, which is always more or less present in raw linseed oil. Chrome green in water is very seldom, if ever, called for and may as well be omitted from distemper color lists, because when mixed with kalsomine for wall painting, it is not only apt to fade badly on account of the usual alkalinity of the white, but tints so made appear yellow under the effect of gas light or electric light.

Composite Green Colors

Under this heading should be classed bronze, bottle, olive and Quaker green that appear in oil color lists, issued by some color grinders. Foremost among these is bronze green, which at the present day, however, is misnamed, as the colors labeled bronze green as a rule resemble either bottle green or olive green. True bronze green was all the rage for store fronts and trimmings during the seventies of the last century and at the Centennial Exhibition at Philadelphia in 1876, the wooden portions of every exhibit and show case were painted with such a green, striped with gold. The effect of this green was nearly black, with a faint tinge of green, when viewed in the shade or absence of strong light, but giving a distinct bronze glimmer in the sunlight. This effect could not be produced, except by mixing a good drop black and chrome yellow of the proper shade.

Very good and lasting results were obtained by mixing and grinding together forty-three pounds powdered drop black (pure bone black), three pounds powdered litharge, five pounds medium chrome yellow, three pounds orange chrome and forty-six pounds fire boiled manganese oil. The latter was used to insure drying as a combination of bone black and chrome yellow retard the drying of oil to quite an extent. We may as well state right here that a bronze green of that character will not find much favor among the trade to-day, at least not as an oil color in paste form.

The trend of the time is to have a dark bronze green of a color similar to what used to be known as bottle green, with a blueish cast, while for a light bronze green

the olive green effect is favored, with this exception that in either case white must be absent. When the very small difference in the price, as given in the lists is considered, it stands to reason that the bronze greens listed are not chemically pure in their pigment portions, although they can be so made if consumers will pay the price for the goods. A very pretty shade of dark bronze green from pure pigment colors can be made in paste form in oil as follows:—

Fifteen pounds lemon chrome yellow, ten pounds dark chemically pure chrome green, thirty-five pounds ivory (bone) black, thirty-six pounds raw linseed oil, four pounds oil drier. For a light shade, mix and grind thirty-five pounds lemon yellow, fifteen pounds medium chemically pure chrome green, twenty pounds ivory (bone) black, thirty-two pounds raw linseed oil and three pounds oil drier. These formulas produce pastes that can be extended with any reasonable quantity of fine barytes, which addition, while taking away a portion of bulk and spreading quality, will not materially affect richness of tone. If the greens are ground fine in the above composition, the dry barytes may be added in the change can mixer with sufficient extra oil to make the paste smooth, and for ordinary purposes it is unnecessary to return it to the mill. This method will save the grinding of a lot of extending pigments. Of course these may also be mixed and ground with the coloring matter from start to finish and in that case a mill of large diameter will produce a large output when well handled. When clearness of tone is not so much of an object as low cost and good covering, working, etc., ivory (bone) black may be omitted and gas carbon black used in its place. On account of the great tinting

power of the latter, the percentage must be rather small in comparison with bone black. A typical formula for a bronze green of fair quality for ordinary painting, ground in paste form for the trade, would be about as follows:—Nine pounds light chrome yellow, seven pounds chemically pure chrome green, dark; three pounds carbon black, twenty-eight pounds barytes, twenty-eight pounds Paris white, and twenty-five pounds raw linseed oil—total, 100 pounds. If well ground this green will not settle in the container and will keep in sealed packages for a long time. If ordinary lampblack is substituted in the above formula for carbon black, a lighter shade of a duller tone will be produced that will pass for Quaker green.

For a good bottle green, which must be of a more blueish green tone to deserve that name, the coloring matter should consist of bone black, dark chrome green of the blueish type, with a small percentage of white, preferably zinc oxide. Twenty-five pounds bone black, powdered; ten pounds chemically pure chrome green, deep; two pounds Prussian blue, three pounds zinc oxide, thirty pounds fine barytes, mixed with thirty pounds raw linseed oil will make 100 pounds of a bottle green in paste form, that will cover well on one coat of lead colored primer and will hold its color. For a bottle green in a chemically pure form, figure on thirty-seven and one-half pounds dry bone black, powdered; fifteen pounds chemically pure chrome green, dark; three pounds Prussian blue, four and one-half pounds zinc oxide mixed with forty pounds raw linseed oil or thirty-five pounds raw linseed oil and five pounds good oil drier. This will be an excellent paste for covering and wear and its cost will not be prohibitive.

Olive green is not found in the oil color lists of color grinders, but they are often called upon to produce such green in paste form, where the consumers or painters desire to do their own thinning. When wanted for exterior woodwork, it may be made from French yellow ocher, chrome green, red and black, with some white. This type is least costly, even when extenders are not used in its make-up. Fifty-five pounds French yellow ocher, three pounds grinders' lampblack, five pounds white lead, two pounds Venetian red, five pounds chemically pure chrome green, medium or dark, all dry, mixed with thirty pounds raw linseed oil, will produce a green of the olive type in good paste form for the purpose named.

When olive green paste in oil is desired for the purpose of using it as a base for a dipping paint for metal, where the paint is to dry flat, yellow ocher must not be used as a constituent, as it is apt to work too puffy. The following will be found a good paste base that will not settle to any extent when thinned with pure turpentine in the proper proportion for dipping:—Six pounds grinders' lampblack, twenty pounds zinc oxide, five pounds red oxide, four pounds medium chrome yellow, thirty pounds chemically pure chrome green, medium, mixed with twenty-eight pounds raw or boiled linseed oil and nine pounds japan drier of approved quality. This will produce 100 pounds of finished paste of a good medium olive green shade. The paste, of course, must be ground very fine in order to avoid an appearance of grit or roughness on the dipped metal, especially when it is to be finished with varnish after having dried. We do not propose to furnish a number of mixing formulas for

composite greens in paste form, as these are too numerous and must be made up specially to suit the requirements of the consumer.

Composite Greens in Japan.

Foremost among these on the price lists are Brewster greens, bronze greens, Brunswick green, Merrimac green, olive green, fern green, etc. There being any number of greens of these types, it would be idle to weary the reader with many formulas, therefore, we shall confine ourselves to give only one for each type and that of a fair medium shade, from which the color grinder may obtain an idea of the pigments required to produce the effect desired, and by varying the quantity of light and dark colors, obtain lighter or darker shades. Take for instance, Brewster green, which has all along been a great favorite in coach and carriage painting. In this green it is necessary to use a good portion of yellow lake, but this being too expensive, excepting where cost is no objection, Dutch pink is substituted for the lake; however, this material should be of a higher type than the ordinary. The grade known as English Dutch pink, that is usually furnished in large drops, which is really made from the waste liquor of yellow lake, will produce best results. To produce 100 pounds of such a green in japan, with a rich tone, mix thirty pounds Dutch pink, powdered; eighteen pounds ivory drop black, eight pounds Prussian or milori blue, with little if any bronze cast, five pounds orange chrome yellow, with forty-two pounds color grinders' japan or gold size japan, grinding the batch on a twenty-inch water cooled stone mill to the standard fineness. This will produce a green of good body, that when applied to

a coach or automobile body, striped with deep orange or imitation of gold color and glazed over with yellow lake in varnish, will give a most beautiful effect. By reducing or increasing the percentage of black and blue, lighter or deeper shades will be obtained in similar tone of color. If it is for any reason inconvenient to mix the dry pigments in the japan and go to the trouble of grinding a small batch, the result may be obtained by mixing thirty-five parts by weight of ivory drop black in japan, forty-two parts by weight of Dutch pink in japan, sixteen parts Prussian or milori blue in japan and six parts orange chrome yellow in japan, adding a few parts gold size japan to make the mixture smooth and giving it a run through the mill to break up any grainy appearance that may develop in the mixing.

To produce a medium shade of bronze green in japan, a mixing may be made of forty pounds ivory drop black, ten pounds medium chrome yellow and six pounds orange chrome yellow, with forty-six pounds of color grinders' japan, yielding 100 pounds finished color, when ground fine in a twenty-inch water cooled stone mill; or in small batches it may be made by mixing eighty parts by weight of ivory drop black in japan, twelve parts of medium chrome yellow in japan and eight parts of orange chrome yellow in japan, smoothing the color by giving one run through the mill, as in the case of Brewster green. By omitting part of the yellows and increasing percentage of black, a darker color is obtained, while by decreasing the black and correspondingly increasing the yellows, a lighter color is had. When a colder tone of bronze green is desired, it will be produced by the addition of a small portion of Prussian blue and when the orange chrome yellow in above

formula is omitted and lemon chrome yellow substituted in its place, a type of green, known as Quaker green is obtained. Lampblack, however, must not be used in grinding any composite green in japan. Brunswick green in japan is not to be confounded with what is known under that name in Europe. It is a very dark green, almost black, and strong light is necessary to distinguish it from the latter, unless the two are side by side. It has been quite a favorite with some railways for the painting of their locomotives and is also used extensively for the painting of stationary engines, pumps, etc., but there is no standard for this color. Some color grinders have made it by simply adding chrome yellow or chrome yellow and Prussian blue, while others added chrome green to ivory or drop black, others again using carbon black and chrome green. We should suggest a mixing of forty-six parts ivory drop black, four parts chemically pure chrome green of deep shade blueish type and fifty-three parts color grinders' japan for a 100-pound batch, to be ground in a water cooled mill or mixing, say ninety-four pounds ivory drop black in japan with six pounds chemically pure chrome green deep in japan. This green is also of the same type as Russian green in japan.

Merrimac green is somewhat similar in composition to Brewster green, but more blueish and deeper and very seldom listed in more than one shade. It is of a sort of bottle green effect in its general tone and has been quite a favorite for painting moderate priced vehicles. A good average formula for a medium shade is as follows:—Thirty-five pounds Dutch pink, twenty pounds chemically pure chrome green, deep shade; twelve pounds ivory drop black and thirty-five pounds

color grinders' japan will produce 100 pounds finished color when ground in a twenty-inch water cooled mill.

Olive Green.

In olive greens there is a wide divergence as to the effect. There was a time when the color turned out under that name in japan was more like the Brunswick green in the dark shade and similar to Merrimac green in the light shade, but no one would dare to offer these at the present time as olive green. A rich shade of this green and comparatively low for cost, is made by mixing eighteen pounds ivory drop black, thirty-two pounds finest French yellow ocher, five pounds burnt Italian sienna and three pounds medium chrome yellow, with forty-five pounds color grinders' japan, yielding 100 pounds finished color that will find favor for painting automobile bodies or other vehicles. Another shade with more of a greenish effect may be made by mixing twenty-two pounds ivory drop black, thirty pounds French yellow ocher and ten pounds orange chrome yellow with forty pounds color grinders' japan, yielding 100 pounds finished color. These olive greens, on account of consisting in part of French ocher, are best ground on a water cooled buhr stone mill, because esopus stones are too soft and iron mills not well adapted for grinding ocher in japan,

There is still another composite green coach color that has found favor, which we will call fern green. It is to be seen on some automobile bodies and delivery wagons and may be mixed from fifty-five pounds chrome yellow, light, fifteen pounds Dutch pink, four pounds ivory black, two pounds chemically pure chrome

green, medium, and twenty-six pounds pale gold size japan, producing 100 pounds finished color.

This color can be ground on any water cooled stone mill, depending upon the size of the batch.

Rare Greens for Coach Work.

Emerald green, a trade name for Paris green, is often called for by coach painters for striping and ornamental work on automobiles and sleighs, but as the ordinary Paris green is not opaque enough to cover, the grade known as pale French Paris green is selected and even this will not be of sufficient hiding power, unless a small percentage of white is mixed with it. Zinc oxide would be least harmful to this pigment of copper arsenite origin, but in order to give it body, white lead is used instead, and the protection of the varnish depended upon to keep the ornaments or stripes from blackening. When intended for striping purposes and to sell as pale emerald green, a grinding of sixty-four parts pale French Paris green, twenty parts dry white lead, twelve parts pale, quick rubbing varnish, three parts raw linseed oil and three parts pure turpentine, will produce 100 parts finished color. Must be ground very fine on a water cooled mill of a size to suit the batch. When desired for glazing over light shades of chrome green in order to enrich these, the pale Paris green must be ground very fine in rubbing or coach varnish without the addition of white and the more translucent the color for this purpose, the more suitable it will be. The proportion of pigment and vehicle in this color should be eight parts by weight of the former to two parts by weight of the latter. Another green for glazing sleigh bodies, etc.,

consists of verdigris, that is used where a rich blueish green tone is desired instead of the yellow toned effect given by emerald green. For this the purest grade of French distilled verdigris should be selected for the pigment and great care taken to avoid its containing free moisture or vinegar when mixing it with oil or varnish. When mixed and ground fine in a high class rubbing or coach varnish, applied over the proper ground as a glaze and protected by good varnish coatings, it is fairly permanent. Requires sixty parts by weight of pigment and forty parts by weight of vehicle, which should be of the character referred to.

Ultramarine green in japan is rarely, if ever, called for nowadays, as the pigment does not work well and the color is not very attractive. When wanted in quick drying character for coach work, it should be of the deep shade and ground fine in gold size japan of good body, because it tends to harden rather quickly in the containers, due to its composition. If the japan is of the quick type, the vehicle should be tempered by adding some raw linseed oil; sixty-five parts of pigment, thirty-five parts of japan and three parts of oil will produce 100 parts finished color and the grinding should be done in a water cooled stone mill of slow running speed.

Zinc green, cobalt green, green earth, oxide of chromium green and Guignet's green have no standing in the coach color line for various reasons, partly on account of lack of hiding power and partly on account of tendency to scaling and dullness of effect. Green lakes of coal-tar derivative origin are not suitable pigments for coach work, for the reason that so far none have been produced that are not apt to liver when ground in japan or varnish.

Miscellaneous Green Colors in Oil.

Paris Green, or emerald green, as it is sometimes designated in oil color lists for the general trade, is an aceto-arsenite of copper, consisting of about 32 per cent. of copper oxide, 58 per cent. of arsenious oxide, 7 per cent. of acetic anhydride, 2 per cent. of sulphur trioxide and 1 per cent. of water. It is a very fine type of blueish green that cannot be imitated with what we know as chrome green, although the latter has made the former almost obsolete in the general line of painting, because of its decidedly poisonous properties. Paris green in oil is still employed to a small extent as a finishing coat over light shades of chrome green, because of its richer effect. The color grinder can test the color or shade and the tinting power of Paris green in the usual way, and a quick test for purity can be had by dissolving a small portion of the pigment in a test tube with strong ammonia. It should dissolve with a deep blue color and show no precipitate. Pure Paris green, being of a rather heavy specific gravity, will not require over eighteen pounds of linseed oil to eighty-two pounds dry pigment to produce 100 pounds of marketable paste. On account of the very poisonous character of the dust arising in mixing the dry powder with the oil, the operator should be cautioned to be very careful in doing the work. The grinding is best done in steel mills, because stone mills are apt to become overheated and will in this case destroy the richness of the green, making it dull and milky. If steel mills are not part of the equipment then the pigment may be ground on mills, the grinding stones of which are freshly dressed.

Verdigris in oil is also to be found in commercial oil color lists, and it is best for the color grinder to select

the material known as French distilled verdigris, which is made by dissolving oxide of copper in acetic acid, the pigment consisting of about 43 per cent. of copper oxide, 29 per cent. of acetic anhydride and 28 per cent. of water, when chemically pure. It is a rather transparent deep, greenish blue pigment, rather fugitive in water, but more permanent in oil, if dried well before mixing and grinding.

There is not much demand for it by painters, but it is used in large quantities by the United States Light House Service for the prevention of marine growth, as the action of the salt water on paint made from this pigment gradually dissolves the cuprous salt, so that animal life or marine vegetation cannot retain a hold upon the surface thus painted. Pure verdigris of the type referred to will require twenty-eight to thirty pounds of raw or refined linseed oil to from seventy to seventy-two pounds of the dry pigment to make 100 pounds of paste color in oil. It requires very careful grinding, as it must be impalpably fine to give satisfaction to the user, especially if the latter be a decorator, who requires it for a glaze. The testing of the dry pigment is very important, as the government service does not allow over 3 per cent. of insoluble matter, which must be considered rather liberal. To test for insoluble matter, weigh out a certain quantity of the pigment, treat it with dilute hydrochloric acid until a solution is effected and if there is any insoluble matter, collect it on a filter, dry and weigh it. Should there be any effervescence noted when treated with acid, it indicates the presence of carbonates of copper or calcium or both. If the color grinder has any cause for suspecting verdigris of being sophisticated, it is necessary to submit a

specimen to an expert paint chemist. The writer has had an experience where a lot of verdigris during the grinding in oil became black and after standing awhile, turned into a solid black mass, similar to cinder. The oil was pure, but the pigment contained free acetic acid and sulphur. The same precautions on mixing verdigris are necessary, as those referred to on Paris green. Neither of these two colors should be mixed with pigments that contain sulphur, owing to the formation of the black sulphide of copper. Such pigments are ultramarine blue or green, cadmium yellow, lithopone, etc., and any apparatus for mixing or milling must be thoroughly cleaned when any of the sulphur compounds are followed by the greens in question.

Green Colors for Artists and Decorators.

Taking these up in alphabetical order, we have first of all bronze green, but as this is a color that artists will prefer to mix themselves, we may pass it by, because when wanted by sign writers or decorators, the manufacturer can fill it into collapsible tubes from such stock as he may quote in his oil color list. The same applies to what we know as chrome green.

Cinnabar Green is a misnamed pigment, as when cinnabar is referred to the first thought leads to vermilion or red, but it is a color recognized by artists and usually furnished in collapsible tubes in three shades, light, medium and dark. The most permanent cinnabar green is made by mixing Guignet's (chromium oxide hydrate) green with cadmium yellow and the next in permanency, a mixture of Guignet's green and zinc yellow. Most fugitive are so-called cinnabar greens that are made of mixtures of Prussian blue and yellow

lake or gamboge. To ascertain whether cinnabar green is made from Guignet's green and cadmium yellow the pigment is extracted in the usual way and treated with a solution of lye. If the pigment is a mixture of Prussian blue and chrome yellow, yellow lake or gamboge, the yellows are extracted by the solution and the blue changed to hydrated iron oxide, while if Guignet's green is present, it will have suffered no change. To produce a medium shade of best quality of cinnabar green, mix five parts by weight of Guignet's green, two parts normal cadmium yellow (cadmium sulphide) and three parts of poppyseed oil, and grind this mixing in a clean stone mill of a size apportionate to the batch until inpalpably fine. Avoid contact with copper or iron as much as possible. For a darker shade, use more green, for a lighter shade more cadmium yellow.

Emerald Green in the list of artists' colors is what appears in commercial color lists as Paris green with this difference, that here the pigment selected is that imported from France and that it is ground in poppyseed or nut oil in place of linseed oil. All the remarks previously made about this pigment apply here.

Color manufacturers in Europe are using any number of fantastical names for this green, because of the reluctance of consumers to purchasing or using it under its original name of Schweinfurt or Paris green. It is sold as opaque, mitis, patent, meadow, Vienna, Leipsic and parrot green. Vert Paul Veronese green is also identical with Paris green. Eighty-five Parts by weight of French pale Paris green and fifteen parts of clarified poppyseed oil is the proper proportion for mixing, although it may be necessary to use a little more oil.

Emeraude Green, also known as vert emeraude in France and as viridian in England, while the German term is smaragd green, is a very pretty, rich green pigment of fine transparency and great permanency, because it is unaffected by dilute acids and alkalies, as well as by sulphuretted hydrogen. Commonly known as Guignet's green, it is the hydrated oxide of chromium green and sixty-five parts by weight of the dry pigment and thirty-five parts by weight of poppyseed or nut oil, make when ground fine in a suitable stone mill, an excellent product for the artist. It is not customary to label this color Guignet's green. The color grinder can test this pigment in the regular way in comparison with other samples, but to be certain of his ground, he should make the dilute acid and alkali test, as there are so-called permanent greens in the market that are intimated to be chromium oxide greens, when in fact, they are merely made from organic dyes.

Oxide of Chromium Green, when so-called, must differ from emeraude green, as this is an opaque pigment, while the latter is transparent. The chrome oxide green is rather olive in color as against the deep rich green of the hydrated chrome oxide, but is even more permanent than the latter, as the strongest degrees of heat will not alter it, while the latter under such heat will lose its water of hydration and return to the olive toned chrome oxide green. This pigment, however, can be purchased at one-third the market price of Guignet's green. Seventy-five parts of the dry pigment and twenty-five parts by weight of poppyseed or nut oil make a good paste for collapsible tubes. The dry green is highly valued for coloring soap and high-grade paper and because of resistance to very high degrees of

heat it is invaluable for use in the ceramic art and in enameling, etc.

Sap Green does not work very well as an oil color, yet it is in moderate demand in the line of artists' tubes. Artists use it as a glaze to obtain certain effects, such as for instance, the leaves of trees in an autumn scene picture. This green is usually made of Prussian blue and yellow lake or Dutch pink of the better grade; when one part of the blue to three parts French yellow lake, ground in four parts poppyseed oil produces a far better, but more expensive green than one part blue and nine parts Dutch pink in five parts poppyseed oil. A far better sap green would be produced, however, for the artists' purpose by a grinding of six parts Guignet's green, two parts super French yellow lake in five parts poppyseed oil, which will prove most expensive of the formulas here given, but also most permanent and best working as an oil color.

Terre Verte or *Verona Green.* This is natural green earth found in the rocks near the town of Verona in the north of Italy. The pigment most acceptable to the use of artists is that found in that vicinity, the Bohemian green earth and that in the United States being too grayish. Terre verte derives its color from ferric oxide and ferrous oxide, that has a gangue of silica with very small portions of alumina and larger percentages of potash, magnesia and soda. For the guidance of the color grinder we will say that the best specimens of natural green earth that are available for the use of the artist, are of a deep grayish green color, that when treated with alkalies or acids, must not show any reaction or changes in color. When a sample of green earth in powdered form is treated with dilute sulphuric

or hydrochloric acid, then washed and filtered, dried and mixed with oil, it must show no appreciable change in color when a portion of the original specimen is mixed with oil and placed alongside of it on a strip of clear glass for comparison. A specimen of green earth that shows up a rich, deep green should be viewed with suspicion and a sample placed in a test tube with absolute alcohol in order to ascertain whether it has not been enriched with a green of coal-tar origin. If such is not the case, the sample should be tested for the presence of Prussian blue by treating it with a solution of caustic soda, which will destroy the blue, if any be present. Terre verte of the highest grade is very rare and very little of it comes to this country, as it is eagerly taken up by the European color manufacturers and the very best selection ever handled by the writer, was quoted by Italian exporters at a figure of $220 per long ton, f. o. b. Leghorn. Specimens of green earth, quoted anywhere from $65 to $115 per ton, were found to be enriched by either Prussian blue or aniline green, while the ordinary green earths, that can be purchased at anywhere from $25 to $45 per ton, cannot be considered at all in reference to artists' color, and at best would pass only as fillers for bronze or olive greens. Bohemian green earth and the green earths found in the United States belong to this class.

To grind the best grade of green earth referred to for use on the palette of the artist, mix sixty-eight parts of the dry pigment, from which every trace of moisture has been removed by subjecting it to a temperature of 150° F. over night, and thirty-two parts by weight of poppyseed oil will make this color of the proper consistency after grinding to impalpable fineness in a stone mill of small diameter.

Ultramarine Green, while found in artists' color lists, is scarcely ever called for in picture or landscape painting, but has been used to some extent by decorators, because of its resistance to alkalies. In this connection the deep shades have had the preference and sixty-five parts by weight of the dry pigment and thirty-five parts of poppyseed oil are the proper proportion for mixing and grinding. It is not profitable to keep much of this color put up in tubes, as there is a tendency for the oil to separate from the pigment and become hard.

Zinc Green, also known as cobalt green or Rinmann's green, named after the Swedish chemist who originally discovered the compound, is valued highly by artists and decorators because absolutely permanent in all painting methods. It is a combination of cobalt and zinc and can be made by intimately mixing six parts by weight of carbonate of cobalt (or ten parts phosphate of cobalt), with thirty parts by weight of zinc oxide, grinding fine as possible and then subjecting the mixture to almost white heat. For a lighter shade, double this quantity of zinc oxide is used. To determine whether zinc green is of the quality and not simply a mixture of zinc chromate and Prussian blue (which latter is unfit for artists' and decorators' use), mix the suspected specimen with dilute hydrochloric acid in a test tube, when the genuine article will readily color the solution a deep pink. If held in the flame of a Bunsen burner with borax on a platinum wire, it should give a deep blue color. About seventy-eight parts by weight of the dry pigment with twenty-two parts of poppyseed oil is the proper proportion for mixing and the grinding should be done on a good stone mill of small diameter, not over twelve inches.

Green Lakes are an uncertain quantity in this line of colors, as unless they are made with alumina hydrate, they do not give the rich effect desired by decorators and when these pigments contain alumina hydrate, they liver so badly after being ground in oil, that in a few days the color will not squeeze out of the tube, besides a color that livers in oil is unfit for use, because it will scale in short order from where it has been fixed. However, decorators and scene painters in theatres have use for green lakes, both of the yellow and blueish type and prefer them put up in tubes of large and convenient size, and if the color grinder specifies that the pigment is to be free of alumina hydrate, the color maker can supply it by precipitating brilliant green on blanc fixe for the blueish toned lake and the same green with auramine or naphtol yellow, also on blanc fixe, for the lake of yellowish tone with the proper mordants. These lakes can be made sufficiently rich for the purpose and being used for interior decoration only, will have fair durability and will not show up yellow under gas or electric light. About seventy parts by weight of dry lake to thirty parts by weight of poppyseed oil will make the right consistency for these lakes. Green lakes of vegetable origin are practically obsolete.

Green Distemper Colors.

In this list we should omit such as bronze green, and, in fact, all composite greens, as well as the ordinary chrome green. When these are called for specially, the color grinder will have no trouble in furnishing them but to keep them in stock is wasteful and unwise. Only very moderate sized stocks should be kept of such distemper colors as are apt to settle or dry up rapidly or

that are rather expensive. In the quick settling line are emerald or Paris green and ultramarine green and in the high priced we have verte emeraude. The list is sufficiently large with cobalt green, emerald green, terre verte, ultramarine green, verte emeraude (or Guignet's green). If cobalt or zinc green cannot be had in pulp form, seventy-five parts of the dry powder should be mixed with thirty-five parts water, given several runs through a stone mill provided with a casing to keep from splashing and when color is smooth and fine, the yield should be 100 parts by weight of finished pulp.

Emerald green in water. Mix any good, bright Paris green, say eighty-four parts dry with twenty-six parts of water, run through mill until fine. Yield 100 parts by weight.

Terre verte or green earth in water. Mix a good grade of green earth in dry powder, say sixty-five parts in forty-five parts water, grind until fine and the yield should be 100 parts by weight.

Ultramarine green in water. Mix sixty-five parts dry pigment with forty-five parts water, grind fine on stone mill and yield should be 100 parts by weight.

Verte emeraude in water. Mix sixty parts dry pigment with fifty parts water, grind carefully without overheating until fine and the yield should be 100 parts. (The pigment in this case is the hydrated oxide of chomium, known as Guignet's green). When an olive green oxide is desired of good body ground in water that will resist alkalies to a great extent, then mix say seventy-four parts oxide of chromium green (ordinary) in thirty-six parts water and grind to a fine pulp. Yield 100 parts by weight.

CHAPTER XI.

MIXING AND GRINDING RED PIGMENTS.

This is also an important group of colors, and by far the greatest interest attaches to the red oxides of iron, natural or artificially made. It may be said that of the total output of most paint factories, one-half, or nearly one-half, consists of red pigments in paste form in oil or in red paint ready for use. That is so far as colored pigments are taken into consideration. Therefore we shall begin with the iron oxide reds. Of these the oil color lists as a rule include Venetian red of several shades, Indian red, light and dark, red oxide, maroon oxide and Tuscan red, which has also oxide of iron for its base. Some manufacturers list extended iron oxides under fancy names, as for instance, Pompeiian red, Mars red, Windsor red, Victoria red, etc., etc.

There never has been a standard for purity as to Venetian red, and up to twenty years ago any extended pigment owing its color to red oxide of iron could be placed on the market under that designation. Before the crusade for pure colors in oil began in this country in 1892, it was no uncommon occurrence that Venetian red paint was applied to iron structures that was found on analysis to consist of less than 10 per cent. sesquioxide of iron (Fe_2O_3), the balance of pigment being barytes and whiting.

Venetian Red.

Venetian Red was originally made by grinding native red oxide or red hematite, but as the use of paint developed the name was transferred by English dry color

manufacturers to the artificial product made by calcining green copperas with more or less limestone that gave a red pigment consisting of about 28 per cent. ferric oxide and 72 per cent. of sulphate of lime (terra alba or gypsum). Large quantities of this sort of English Venetian red were exported to this country, but since the American manufacturers made great progress in the production of oxide of iron paints, imports have been reduced to quite an extent. The color grinders of twenty years ago had in their oil color lists a red generally labeled English Venetian red over their own name, and in that case it was a dark red, consisting in its pigment portion of 35 to 40 per cent. sesquioxide of iron, balance usually being gypsum (sulphate of lime). Venetian red in oil, consisting of less than that percentage of iron oxide, was hardly ever labeled with the manufacturer's name. One certain firm listed three shades of Venetian red in oil, light, medium and dark. The pigment used for the light or bright shade was made by mixing the highest grade of a scarlet red oxide known at one time as Forest of Dean or Crawshay red, that showed by chemical analysis 96 to 97 per cent. Fe_2O_3 in such proportion with hydrated sulphate of lime (gypsum), that it would invariably show on analysis 20 per cent. Fe_2O_3 and 80 per cent. $CaSo._4$ On account of its bright color this red had a remarkable sale. The medium shade of Venetian red was a copperas red, averaging 40 per cent. Fe_2O_3 with very little deviation, balance being sulphate of lime, dead burnt in the furnace along with green vitriol (copperas) and a trifle of silica. The dark shade of Venetian red consisted in the pigment of a mixture of Persian Gulf red and hydrated sulphate of lime (gypsum) averaging 35 per cent. Fe_2O_3, 15 per cent. silica and alumina (SiO_2 and Al_2O_3) and 50 per cent.

$CaSo_4$. The mixing and grinding of the light and dark shades of the red referred to was accomplished in the dry state by first mixing the material and expelling the moisture on steam heated iron drying pans, and then grinding the material so mixed to impalpable fineness on stone mills of 36-inch diameter before mixing the pigments in oil. Either of these three red pigments could be mixed and ground to a smooth oil paste on 20 or 24-inch stone mills (esopus stones) by mixing 77 pounds of pigment to 23 pounds raw linseed oil, while by the use of fire boiled linseed oil it was possible to mix 79 pounds pigment and 21 pounds of oil. This bit of history is not related as a suggestion to follow, as present day color grinders would hardly care to do so in the face of the competition. Any color grinder who may have before him the specifications of the United States Navy Department can draw his own conclusions as to the adoption by that service branch of the government of the chemical constituents of the reds above described. These specifications are still in force at the present time with this one exception, that they originally called for a mixture of so much sesquioxide of iron, not over 15 per cent. of silica, balance to be sulphate of lime fully hydrated, while some nine or ten years ago this passage was changed to the wording:—"Balance to consist of sulphate of lime that has been dead burned in the furnace, so as to render it incapable of absorbing moisture again."

The reason for this change is obvious. When gypsum is only partly hydrated it is apt to take up moisture from the air, even when mixed with linseed oil to be applied as a paint and even after application. It is also claimed by chemists that one part of gypsum can be dissolved in 500 parts water, but when it has been

dead burned it cannot be dissolved no matter how much water is used. Most of the color grinders to-day place only one shade of Venetian red on their list, and that of the medium type, carrying anywhere from 30 to 40 per cent. of sesquioxide of iron.

When it comes to a second or even third grade line of colors, as many makers are listing, the usual practice is to extend the red still further with barytes, the one inert mineral base that absorbs the smallest percentage of oil, thus meeting the demand for very low priced Venetian reds that are often mislabeled iron oxide red. As an example, we will assume that a typical Venetian red in oil costs the maker $2.75 per 100 pounds for material, not figuring labor and fixed charges or packages; a second grade like the one mentioned, if made from the same pigment with its own weight of a first grade of barytes and pure linseed oil as the vehicle would cost $2 per 100 pounds for material, figuring on a mixing of equal parts of dry red and barytes, ground with 15 per cent. by weight of oil. A red of this quality in paste form would still show by analysis about 14 per cent. of sesquioxide of iron in the pigment, and on thinning for use covers up nearly as well as the normal Venetian red, but on comparison, pound for pound, would not absorb as much thinner and therefore be deficient in spreading capacity. Third grade of Venetian red or oxide of iron reds, so-called, usually do not contain in their pigment portion over 7 or 8 per cent. of sesquioxide of iron, and a cheap grade of barytes is used as extender, unless the vehicle is a paint or putty oil of mineral origin, when a lighter extender, such as cheap whiting or marble dust, is introduced in place of barytes in order to keep the paste from hardening in the package. Nor is a

good oxide of iron introduced as the coloring principle, though it would prove far better, but often an ordinary red ocher or clay. Being of the opinion that manufacturers who prize their reputation more highly than temporary gain, will not cater to the demand for this class of goods, we shall not dwell further on the subject and proceed to deal with

Freight Car Reds

in paste or semi-paste form. Nearly every color grinder of repute is familiar with the specifications at present in force for freight car red called for by the Pennsylvania Railroad Company, the first one of the railway companies in the United States to issue specifications for paint material to be used on their rolling stock and other equipment. But it may be of more than passing interest for the younger element in the business to learn how this feature developed to its present stage. The latest requirements that have been in force for some years call for a red in paste form consisting of 74 per cent. by weight of dry pigment, 1 per cent. of moisture and 25 per cent. of oil. The pigment to consist of 25 per cent. of sesquioxide of iron, not less than 2 nor more than 5 per cent. carbonate of lime, balance to be inert material not less opaque than sulphate of lime fully hydrated or such silicious inert material as occurs with oxide of iron in nature, or a mixture of these. The oil to be strictly pure, well settled raw linseed oil. When the late Dr. Charles B. Dudley, who was then chief chemist for the P. R. R. Co., having charge of the laboratories at Altoona, Pa., in 1888 first conceived the idea of issuing specifications for freight car color, he not only consulted the superintendent and master car painter at the Al-

toona shops, but also several prominent paint manufacturers, and his first step was to order several barrels of red oxide of iron paste in oil, paste form, that was to have in the dry pigment not less than 60 per cent. by weight of pure sesquioxide of iron, while he left it to the various manufacturers what extender should be used if any were necessary. Upon investigation he found that 50 per cent. of sesquioxide in the pigment was sufficient to give all the hiding power that was desired, also that there were excessive percentages of moisture present in the paint furnished, and asked for a paint that would be practically free of moisture, but upon being furnished with a trial lot that did not show over one-quarter of 1 per cent. of moisture, because the dry pigment had been subjected to a heat of 350 to 375 degrees F. and mixed with the raw linseed oil, while still showing a temperature of over 200 degrees F. before running the material through the mill, he found that the paint did not at all give proper satisfaction in his tests. This was no doubt due to the partial dehydration of the gypsum constituting the inert base, brought about by the excessive degree of heat used in trying to expel all the moisture possible from the pigment. After that Dr. Dudley insisted on the extracted dry pigment from his freight car red paste, showing one full per cent. by weight of moisture, and not long afterward made his specifications for this red require only 35 per cent. by weight of sesquioxide of iron, which was finally further reduced to 25 per cent. The idea of requiring from 2 to 5 per cent. of carbonate of lime in the dry pigment was to neutralize any traces of free sulphuric acid that might be present if the red oxide in the pigment was of the artificial sort made from copperas. The reduction of the percentage of iron oxide in the pigment was made for

economical reasons, because it enabled color grinders to furnish the material at lower prices. Another point of consideration appears to be that it was unnecessary expenditure of money to place higher priced material on this equipment, as it would need repainting as frequently even with the more costly material.

Oxide of Iron Red.

Oxide of Iron Red in Oil as found in some color grinders' lists is usually a mixture of native red oxide, or it may be a copperas red, containing any where from 70 to 90 per cent. sesquioxide of iron in the native red, with a gangue of silica and alumina, as occurs in nature with the oxide, while the red oxide made in the furnace from green copperas may run about 60 to 70 per cent. in oxide, the inert material consisting of dead burned sulphate of lime. These reds are usually of medium or dark shades, and will require the same proportion of pigment and oil for mixing and grinding as the best grades of Venetian red noted above, that is, about 77 pounds of dry pigment and 23 pounds raw linseed oil. In native reds the Spanish and Persian Gulf reds are excellent types and are lower in price than the copperas reds of similar percentages, though the latter are usually much richer in color.

Maroon Oxide in Oil, when so branded, may be a deep Indian red, or it may be Persian Gulf red.

Indian Red.

Indian Red in Oil is listed by some grinders in one shade only, and here a medium shade is selected, while others quote light and dark shades. Indian red is made

artificially from green copperas, and Leech, Neal & Co., of Derby, England, practically monopolized the sale of Indian reds in this country for a long time, but of late years several dry color makers succeeded in making inroads on the sale of these reds and also on some of the strong, bright red oxides.

Indian reds, like all the oxide of iron pigments, should be selected by the color grinder by comparing them in making rubouts, testing for fineness, tone, shade and tinting strength, but in testing Indian reds extra precaution is necessary in order to avoid trouble after the oil color is in stock or in store, packed for the market, to see before mixing that any free sulphuric acid is neutralized, and also that it is as free from alkali as possible. When Indian red is being levigated before it is being dried and packed in casks or other containers for the market, an alkali, usually milk of lime, is added to neutralize all traces of acid, but if lime is added in excess it is liable to saponify a portion of the oil on mixing, and so tending to turn the paste into a liver-like mass or at least to make it necessary to add extra quantities of oil to keep the paste in good condition. Any color grinder who may intend to bid on proposals for supplying Indian red, dry or in oil, to the Naval Supply Fund should carefully read over the United States Navy Department specifications, which are very exacting on the acid and alkali feature, in order to save himself from eventual loss through rejection. Chemically pure Indian reds contain from 96 to 98 per cent. sesquioxide of iron, balance being silica and calcium sulphate, and can be mixed and ground at the rate of 83 to 84 pounds dry pigment and 16 to 17 pounds raw linseed oil. Boiled oil is not well adapted for grinding

Indian red that is put up in containers for sale in paste form, as it is usually too limpid to hold the heavy pigment in suspension. Raw linseed oil free from foots and somewhat aged is best. All of these reds based on oxide of iron are best ground in oil on mills of large diameter if the size of batches warrants it. Any diameter, from 20 inches to 36 inches, will be proper, providing the mill is run at a speed conforming to this.

Mars Red, properly speaking, is an artificial color made by calcining Mars yellow at red heat. Mars yellow should be a precipitate of copperas and alum, but French ocher is sold under that name, and French burnt ocher as Mars red. This burnt ocher will require a mixing of 74 pounds of dry pigment and 26 pounds raw linseed oil for 100 pounds marketable paste.

Tuscan Red.

Tuscan Red in Oil.—These reds are a somewhat uncertain material so far as a standard for them is concerned. The color sold under the brand English Tuscan red is not up to some of the proprietary brands made by color makers in the United States, and some of the reds offered by British manufacturers as Tuscan are simply maroon lakes of uncertain origin very much reduced. Up to about the year 1887 the dry color sold as Tuscan red was made by American color makers by precipitating upon a base of about equal parts pure Indian red and English cliffstone Paris white a certain quantity of the mother liquor of rose pink made from Brazil wood, which made a rich color, but a pigment not very strong in hiding power nor very permanent. About that time the general business manager of a prominent paint firm, now long deceased, copyrighted a

brand of color under the title "new Tuscan red" that was made in their own color making establishment, and the formula was quite secret for many years. This Tuscan red, though not of great hiding power, is quite rich in tone and very permanent, standing high degrees of heat and exposure to light to a remarkable degree. It was made in three shades, but only the medium shade had a remarkable sale for a long time, though the other two shades also sold well. The base of this red is also chemically pure Indian red mixed in water, to which is added about its own weight of calcined sulphate of lime, also hydrated or wet up with water, both of these run into a striking tub and precipitated upon this base is a certain portion of alizarine red paste or mother liquor. When the mixture is effected the color is washed repeatedly, the precipitate filtered, dried and powdered.

Tuscan red so made, mixed with raw linseed oil, requires 72 to 73 pounds dry pigment to 27 or 28 pounds oil for 100 pounds of paste in oil, holding well in suspension in the containers. A Tuscan red of similar permanency and richness can be made by mixing and grinding 45 pounds dark Indian red, 10 pounds of alizarine red lake and 45 pounds gypsum in 30 pounds raw or refined linseed oil, yielding 128 pounds of paste, allowing for waste. Or still better to save expense in grinding, grind the alizarine red lake separately in its own weight of linseed oil impalpably fine, mix 15 pounds of the resulting semi-paste with 36 pounds each dry Indian red dark and gypsum and 15 pounds raw linseed oil, and the result will be 100 pounds net of Tuscan red paste. Lighter or deeper shades can be produced on same formula by simply using light or extra dark Indian red in place of the dark shade.

A cheap grade of Tuscan red can be made by mixing Indian red and gypsum in convenient proportions, adding sufficient of a carmine substitute pigment otherwise known as scarlet lake or azo-scarlet. While this color is neither permanent on exposure nor heat resisting, it is as good as many consumers desire to have it. By mixing 30 pounds Indian red, light or medium, 40 pounds gypsum, 10 pounds of azo-scarlet lake G, with 22 to 23 pounds of boiled linseed oil and grinding same fine, 100 pounds of a fairly rich red of the Tuscan red type will be the result.

As we remarked at the beginning of the paragraph on Tuscan red, there is no accepted standard for this color, and all that is known about it is that it should be rich permanent red, such as cannot be obtained from even the richest red oxide of iron. Of late some grinders have made their grindings of Tuscan red by mixing in some instances Indian red, in others deep red oxide of iron or Venetian red with some of the so-called body toners of the para nitraniline or beta naphthaline group, selecting such as are least apt to bleed out. Because of this practice no two grinders are producing shades of Tuscan red that are precisely similar, unless they are given samples to match. Pompeiian red in oil, if called for, can be filled out of a grinding made from Persian Gulf red, while Windsor and Victoria reds are simply Venetian reds low in cost.

Before closing the chapter on oxide of iron reds it will be interesting to mention the Tuscan red body color used by the Pennsylvania Railroad for many years on their passenger car equipment. Here is where the late Dr. Dudley and his assistant, Mr. E. N. Pease, broke with the established custom of having the pigment

ground in coach japan, falling back on a practice in vogue before the grinding of colors in japan was thought of. The idea was to grind the dry pigment, that was to be composed of oxide of iron and a fairly permanent lake in a vehicle that would not be apt to cause livering in the paste form, as well as to enable the chemists to more accurately determine the constituents of the material, especially the vehicle, than would be possible if the pigment was ground in japan. It was to do away with the overheating in milling and enable the management of the shops to introduce a uniform rule of thinning the paste color for application. The specifications that were issued over twenty years ago and have, with very trifling modifications, been in force ever since, are in substance as follows:—P. R. R. standard car body color Tuscan red is to consist of 75 per cent. of pigment and 25 per cent. of vehicle by weight. The pigment desired consists of 80 per cent. by weight of sesquioxide of iron, not less than 2 per cent. nor more than 5 per cent. carbonate of lime, balance to be inorganic coloring matter of a character approved by the testing laboratories of the company at Altoona, Pa.; the vehicle to consist of 36 per cent. of well-settled pure raw linseed oil and 64 per cent. of pure spirits of turpentine by weight. This was followed by the usual caution about fineness of grinding, matching of the shade to the dry standard furnished and the deviation allowed without rejecting the shipments, which practically bars out such as are deficient in the percentage of oxide of iron, contain less than 8 per cent. or more than 10 per cent. of raw linseed oil in the paste, any oil other than raw linseed oil or any that contains, in the pigment, coloring matter of organic origin or such that has not been approved. For several years past permission has been given manufacturers

to cut down the percentage of inorganic coloring matter or to omit it entirely, providing they can furnish the standard shade without such addition, which, however, will be found an impossible task, as the oxide of iron of the maroon shade required, with the brilliancy or richness of tone needed, has yet to be discovered. While at first and for some years alizarine red lake was approved as coloring matter in preference to all others, it would appear that of late coloring matter of the paranitraniline, the orthoanisidine or toluidine groups of coal-tar derivatives are accepted, and as these so-called toners are far stronger than the alizarine reds it enables color grinders to conform to the specifications as to percentages of pigment and vehicle with far less trouble than had been the case when using alizarine red, which really required excessive portions of vehicle. The shops are given instructions as to how the paste color is to be thinned for use with certain portions of coach japan and spirits of turpentine and the addition of a small portion of varnish for finishing coats. The principal object of this method is to obtain more durability and wear because of the better elasticity and uniformity of the paste so ground as against the same color ground in japan, the theory being that the heating of the material in the milling is not conducive to good results. But while this method of grinding a color of the composition of the P. R. R. Tuscan red appears to work well, it has been found impractical in the case of another railway company that has attempted to introduce it into their Pullman shade of car body color because of the great portion of vehicle required. It was found on thinning the color so ground that an excessive quantity of japan was required to make the color dry within reasonable time, and that this large portion of japan impaired the

hiding power of the color. Furthermore, the master car painters found that they were unable to get out the cars from the shops on schedule time, thus causing the motive power department to abandon the practice and returning to the use of color ground in japan.

Bases for Oxide of Iron Dipping Paints.

When grinding red pastes for use as base for dipping wood or metal it is not practical to assume that any ordinary oxide of iron red will be good enough for the purpose. The chief points in the property or characteristic of such base are that it must hold well in suspension when thinned for use with the volatile liquids usually employed for the purpose; that the pigment when settling or standing about for a time must not cake hard or be gummy in the bottom of container; must be so as to readily reincorporate with the thinners and must cover well the objects on dipping when the paint is made thin enough to drip freely. To attain this end it is by far the best policy not to select red oxide or Venetian red low in cost, but to disregard cheapness in first cost and select grades that are high in percentage of sesquioxide of iron and add a base of light specific gravity to furnish the buoyancy for keeping the paint well in suspension. To enable the grinder to determine the proper kind of inert base he should know for what particular purpose the dipping paint is to be used. For instance, when used for sheet metal or tin, the less inert base is mixed with the iron oxide the better the paint will drip and cover the metal, while for dipping cast-iron parts a base with a good filler is desirable, and the same applies to the dipping of articles of open-grained wood, such as is used for agricultural implements and on cheap wagon work. For example, if a red dipping paint of the type of

Venetian red is desired, select a red oxide containing as nearly as possible to 90 per cent. of sesquioxide, grinding it very fine in boiled linseed oil to a soft paste, which will require close to seventy pounds pigment and thirty pounds of oil. If ground in this way and thinned with the proper drier and either spirits of turpentine or one of the heavy benzines, known as turpentine substitutes, or ordinary naphtha, as the case may be, the paint should cover well, adhere firmly, leaving only a thin film on the surface that will not sag or run. If a maroon shade be required Indian red or the deep shade of Persian Gulf red can be substituted for the brighter Venetian red type or shade of red oxide. On the other hand, where filling up qualities are desirable an artificial oxide of iron red, containing anywhere from 30 to 40 per cent. sesquioxide of iron, with a base of dead burnt calcium sulphate, will supply the filling without any further addition, or a native red of the 90 per cent. type mixed with its own weight of fine silica and bolted whiting ground at the rate of 72 per cent. by weight of the mixture of pigment and 28 per cent. of boiled linseed oil will make a good base for a dipping paint for cast-iron parts or wooden parts of machinery or wagon work. When quick drying is required part of the oil is omitted and a good japan drier used in its place, while the linseed oil should be changed from boiled to raw linseed oil. These bases will answer equally well for gloss and for flat drying dipping paints, the difference being in the thinning of the bases.

Mixing and Grinding Red Lead and Vermilion in Oil.

When pure red lead in oil is demanded by the trade the manufacturer usually grinds it to order only, though

he may keep a small quantity in stock in small cans. But it is an established fact that pure red lead, no matter how well made and how carefully mixed with pure linseed oil and ground without friction, will not keep from becoming solid in the containers in paste form for any length of time, nor will it, when mixed ready for application, hold in suspension or keep from going to the bottom of the package, finally caking hard. Many trials have been made and every one failed of its purpose. There are now on the market red lead products in ready-for-use form in oil, so called, but when examined they are found to consist of basic lead chromate colored with red coal-tar derivatives, and while resembling red lead are devoid of the cementing properties of the latter. When a certain percentage of non-drying oil is added to linseed oil in the mixing of red lead one would naturally expect to see the hardening or saponifying tendencies retarded; but such is not the case, at least not in the measure looked for. However, when red lead in pure linseed oil is wanted for work that is to be done at once or where the paint is to be used inside of a month, well-selected red lead may be mixed at the rate of ninety-one pounds to nine pounds of well-settled raw linseed oil and run, if necessary, through an iron or steel mill of large diameter into the package in which it is to be shipped, but care must be exercised to keep the mill from heating. The use of stone mills must be avoided, as the friction of the stone breaks up the crystalline particles of the red lead, dulling its brightness and causing a more rapid oxidation of the oil. The red lead and eosine vermillion reds or vermillion substitute, when ground without the addition of inert bases, exhibited similar tendencies. This was the reason why the implement manufacturing trade, before the advent of the paranitraniline reds,

preferred to purchase their wants of vermillion reds in the dry powder form with more or less inert mineral base. To this saponifying or solidifying tendency of red lead in oil was also due that the government services specify all red lead to be supplied in the dry form, as they also used to specify their English (quicksilver) as well as the artificial vermillions. Eosine vermillion reds, based on French orange mineral, would keep well in sealed cans when ground in well-settled raw or bleached linseed oil, excepting the very deep shades, that contained quite a large portion of eosine coloring matter; those not containing over 2½ to 3 per cent. would keep soft in paste form for a year in well-sealed packages. The usual percentage of pigment was eighty-four to eighty-five pounds in a one hundred-pound batch, the oil fifteen to sixteen pounds. English vermillion has kept best in containers when ground in these proportions, although it also tends to settle badly when put up in the pure state. This was one of the principal reasons why, up to twenty-five years ago, neither English nor artificial vermillion was ever put up for the trade in oil without the addition of a suspending base, like whiting or china clay. The ready-for-use red lead paints found on the market to-day are usually pure red lead reduced with such mineral bases to keep in suspension and meet competitive prices. A red lead paste paint in linseed oil that showed fairly good covering after being properly thinned with raw linseed oil, oil drier and a small portion of turpentine showed on analysis to be composed of fifty parts by weight of red lead, seventeen parts by weight of china clay, seventeen parts by weight of whiting and sixteen parts linseed oil. This paste kept soft in a sealed metal package for over six months. The utmost precaution, however, is

necessary to keep out any resinous matter. Bright red barrel paints that always have the so-called gloss oil (rosin and benzine liquid) for their vehicle could not be made with red lead and eosine vermillions as the coloring principle, as they would invariably solidify under such conditions.

American Vermilion (Chrome Red) in Oil.

American vermillion, or, as it is commonly known by most painters, scarlet lead chromate, has also been placed on the market under names or brands such as Chinese red, Persian red, Imperial Scarlet and others. It is a basic lead chromate, a pigment of great hiding power and fair permanency of color, although turning brownish on long exposure. As it does not blacken like quicksilver vermilion or fade to a pinkish white, like eosine vermillions, the Pennsylvania Railroad Company used it for over twenty-five years on their cabin cars, or cabooses, changing only recently, of which we shall speak shortly. Other systems used mixtures of this chrome red and Venetian red for their cabooses, while twenty years or more ago some implement and wagon manufacturers in the West used great quantities of it until the desire of purchasers for more brilliant reds induced them to change. It is generally made in two, but sometimes in three shades—extra light, light and dark. The writer has found some brands on the market ground in oil that were extra rich, but on examination showed that the extra brilliancy was due to the addition of a small percentage of eosine. To grind the light shade of this red in oil requires eighty-five pounds of pigment and fifteen pounds of oil for one hundred pounds of paste, and the oil should be of good body and

fire boiled, otherwise it will settle quickly and is apt to cake on settling. It is best ground in iron mills of a size consistent with the amount of the batch or on roller mills, and care should be taken to prevent too much friction and heat on grinding because its color is easily damaged, producing a dull orange color. The Pennsylvania Railroad Company, who have used very large quantities, purchasing this color in the dry powder form, have lately issued preliminary specifications for cabin car red that call for toluidine red ground in oil paste form at the rate of 42 per cent. by weight of pigment and 58 per cent. by weight of well-settled pure linseed oil, the manufacturer who proposes to bid on the requisitions for this color to submit first a sample of the dry color for approval by their laboratory. The color is to be as non-bleeding as possible; in fact, should not bleed at all, which, however, will be found a very difficult matter to be complied with. When speaking of a pigment as bleeding it may imply that it does give up a portion of its coloring principle, as the case may be, in water or in oil or varnish, but in the case just quoted it is expected that when this red is fixed upon a surface as a paint it shall not give up part of its color to lettering or stenciling in white, as is the case with all paranitraniline reds, which color the vehicle they are ground in, and unless an isolating coat of varnish is applied over the fixed color the red will invariably strike into the white to a greater or lesser extent. This feature is not so prominent in most of the toluidine reds; in fact, there are some specimens that the writer has tested out in which bleeding is scarcely perceptible, yet it seems to be utterly impossible to find any that do not show a slight trace of the bleeding. A quick and reasonably certain test is to weigh out on a medicinal prescription scale

similar portions, say five or ten troy grains of each specimen sample to be tested, and rub up on a marble slab or a slab of clean glass each of these with a similar number of drops of oil, using a clean spatula for each rub-out, which should be as liquid as a ready-for-use paint, and put a few drops of each rub-out on a piece of clean white blotting paper, when the bleeding will show itself as a yellow or brown ring about the circle of red. To accelerate the test hold the blotting paper over a flame, but not close enough to scorch the paper. Of course each of the samples on the blotter must be given as nearly as possible similar degrees of heat.

Toluidine Red surpasses any of the latest developments in the line of reds produced from coal-tar derivatives in point of permanency to light and gases, and certainly even if more costly than American vermillion it makes up for such cost to a good extent in spreading power, pound for pound of paste. It is now generally known among color makers as government fast red, and is an improvement over the lithol vermilion specified by the United States Navy Department in some of their proposals, inasmuch as it is not required to use orange mineral as the base with the toluidine red.

The So-Called Permanent or Non-Fading Reds in Oil.

About the year 1894 the representatives in this country of some English and German manufacturers of coal-tar dyes and aniline colors visited some color makers whose line of dry colors was mostly used by paint makers with a view to disposing to them the dyestuff necessary to prepare a new line of fast reds much more permanent than the azo-scarlets and really more brilliant. These were known as paranitraniline and betanaphthaline,

and at that time furnished in dry powder, leaving it to the color makers to develop the reds by diazotizing the dye and precipitating it upon such bases as they thought best. Some color makers supplying the printing ink trade had already developed a red from these dyestuffs upon a base of barytes and named the resulting material poster red ink, because it was being used for that purpose principally, being rather low priced in that quality, the coloring matter in the pigment not exceeding 5 per cent. To be short and to the point, it may be said that the experimenters at first, when making the pure red without a mineral base, despaired of ever being able to make use of the red as a paint material, because the toner, which it really was, as then made, would not dry with linseed oil or even coach japan within reasonable time. However, after a great deal of experimenting it was found that barium sulphate, in either the artificial or natural form, as blanc fixe or barytes constituted the best base upon which to fix the diazotized paranitraniline. While some firms made three grades of the red in oil, the best carrying 16 per cent. coloring matter, the next 12 per cent., the lowest 8 per cent., with a base of equal parts natural barytes and whiting as the balance of the pigment, others made their best quality 25 per cent. color and 75 per cent. blanc fixe, using in the mixing in oil 88 per cent. of this mixture of dry pigment and 12 per cent. best French orange mineral, having excellent success in marketing the goods ground in oil as well as in japan, in the latter case omitting the orange mineral.

A prominent firm of London, England, as early as 1897, although having no business connection with the American firm whatever, offered samples of what they called non-fading red, which in almost every particular equaled

the product on which the latter had such a great run, but for some reason or other the red offered by the British manufacturers did not obtain any foothold in this market. By the time the Spanish war in 1898 was over, we had any number of para reds, so called for short, on the market under fancy names, the most common of which was devil's red, while the victor at Manila Bay was honored by one brand being named after him, "Dewey" red. Others used such names as permanent, perma, parma red, while others again used the word vermilion, prefacing it with a number identical with the year of their establishment in business. Prominent bulletin sign writers found it to their advantage to use the red on a blanc fixe base, its superior spreading quality equaling the difference in price, and the absence of carbonate of lime giving better wear. One great railroad system adopted for their red signals paranitraniline red of a light shade, the coloring matter to be composed of at least 23 per cent. of the diazotized paranitraniline on blanc fixe, 88 per cent. by weight of this and 12 per cent. by weight of orange mineral to constitute the pigment, same to be ground in pure raw linseed oil at the rate of 65 per cent. by weight of the dry material and 35 per cent. by weight of the vehicle.

The idea of the addition of orange mineral is to add opacity to the color and to aid in its drying without the necessity of using an excess of liquid drier when thinning the paste color for application. While these reds, which we will also call para red for short, have proven themselves far superior in point of permanency to the artificial vermilions or vermilionettes, whose coloring principle was eosine, they did not give uniformly good results, and many batches of the color failed on exposure

in practical use. While this could not always be traced to the coloring matter or its composition, in many cases, the failure was due to imperfect washing, the portions of caustic soda used in the process remaining in the dry color, acting disastrously on the vehicle, the paint losing its luster and streaking or turning white in a short time especially when used as an oil paint.

With the great number of para reds from orange to the deepest maroon, so-called toners, that can be obtained either pure or fixed on various percentages of inert bases, it is not difficult for the color grinder to select such as he may be in need of and mix them in such proportions with barytes, blanc fixe, china clay or whiting as may be required to suit his trade. With the litmus paper test he can readily determine if the color is free from alkali, but he must be very careful in grinding the paste that the mill does not become overheated, as this will ruin the color. When grinding para reds in paste form, that are selling at low figures for implement and wagon painting, the usual practice is to have a base of barytes when the red is for brush work, while when it is to be used for dipping, the barytes base is too heavy in gravity and whiting, clay and asbestine are substituted. In the former case 5 per cent. of toner in the pigment portion is usually the limit, while in the latter case the percentage of toner must be greater because of the greater absorbing power of the base, and from 6 to 8 per cent. of toner is usually required. The color grinder who works on limited capital and has a trade in proportion will find it to his advantage to grind pure toner in oil, setting it aside in well covered containers so that it will not be necessary to grind a batch every time an order is passed to him, and thereby have a lot of waste. By keeping

the toner on hand in paste form in oil, he can grind his base in oil and then in a suitable mixer add the coloring matter, in such proportions as may be required to meet selling price. It is scarcely worth while to say more about these reds, as there are new types placed on the market so very frequently, and we will pass on to the red lake colors in oil that are still to be found in oil color lists, most prominent among which is *Rose Pink*, a deep maroon, that up to twenty years ago was made from the wood dye known as sapan wood and Lima wood, precipitated with alum as the mordant upon a base of whiting or whiting and gypsum, but is now prepared with aniline dye as the coloring principle, such as magenta or orseilline, the latter being by far the better of the two, being more fast to light and less inclined to bleed. Rose pink, being a slow drying pigment in itself, is best ground in boiled oil, as it is mostly used in the making of stains and by grainers. The usual proportions of pigment and oil required to produce a marketable paste is 72 per cent. by weight of the dry material and 28 per cent. of oil, varying according to the nature of the base. Like all lake colors, rose pink is very apt to liver unless well dried before mixing with the oil, and it must be free of alumina hydrate.

Rose Lake, as a rule, is simply a color of the same type as rose pink, but of at least double, sometimes treble, the strength shown by the latter, and also more brilliant in the undertone. Does not contain gypsum as a base, but usually alumina sulphate. The best grades will require anywhere from 60 to 65 per cent. pigment and 35 to 40 per cent. of oil to form a paste in oil.

Scarlet Lakes or Carmine Substitutes, under whatever fancy name they may be listed, are of the acid and dye-

stuffs substantive color type precipitated with barium chloride, and may have Bordeaux, wood ponceau or scarlet for coloring principle. This color is a decided bleeder unless well fixed upon its base of barium, and the barium chloride having changed during the precipitation process to artificial barytes, it will require a mixing of two-thirds by weight of dry pigment and one-third by weight of oil to form a paste. On exposure to strong light and noxious gases it is as permanent as carmine, which is not saying much, because in about six months either color will be almost gray under these conditions. This red is also sold as Turkey red in oil, since the red oxide sold under that name years ago has gone out of the market.

Permanent Red Lake is a name for alizarine red lake, copyrighted by a New York color maker some twenty-five years since. When this color is properly prepared, free from all traces of iron, it is a rather brilliant red, and while not as rich as carmine on first exposure, it will distance the latter in richness of tone within three months. In tests made by the writer he found that alizarine red lake after seven years' exposure showed up more brilliant by far than an unexposed sample of the same color kept under cover that length of time. This, of course, was in a measure due to the bleaching of the dried oil film in the exposed sample, while the oil film in the unexposed counter sample darkened with age. Carmine No. 40, exposed at the same time and place, had completely gone to ashy gray in fourteen months. Alizarine red lake requires its own weight of oil for a paste of medium stiffness, and the finer it is ground on a good esopus stone mill the more brilliant will be its tone.

Red Colors for Artists' Tubes.

The usual vehicle for these consists almost exclusively of poppyseed oil, although with permanent red lake, refined linseed oil is probably best, as this color is favored by sign writers and decorators for lettering on glass. The colors for the artists' list in red may be named as follows:—Carmine, carmine lake, chatemuc lake or crimson lake, madder lake, permanent red lake, rose doree, rose madder, scarlet lake, Venetian red and vermilion. Each color must be ground exceedingly fine, yet be of good consistency in order to avoid separation of oil when squeezing the color from the collapsible tube. To avoid waste in filling tubes, a tube filling machine, similar to a sausage stuffer, is best adapted for the work, and the tubes should be long enough to permit of their being closed up at the end by bending over the metal three times.

For *Carmine,* either No. 40 or amaranth will be of the proper tone, and usually equal weights of color and oil will make the color of the right consistency. For carmine lake a non-bleeding color is required, and the best pigment for this is a cochineal lake that can be ground at the rate of 60 per cent. by weight of the lake and 40 per cent. by weight of oil. This is simply carmine reduced with a white base.

Chatemuc or Crimson Lake.—These must be non-bleeding and are best made of a mixture of cochineal lake and a wood lake of the type described as being made from sapan or Lima wood decoctions; should require about same proportions of oil and pigment as carmine lake.

Madder Lake and Permanent Red Lake may be of similar composition that is ground from a fine grade of

dry alizarine red lake in its own weight of poppyseed or bleached linseed oil, while *Rose Doree* is natural madder, at least it is made from an extract of the madder root, known as garancine. The dry color is known as lake garance No. 6, and in the dry powder appears rather pink. When ground in oil it is transparent and produces the most delicate pink effects on artists' pictures.

Rose madder may be ground from a selection of very rich alizarine red lake that is utterly devoid of any traces of the brownish tinge usually due to the presence of iron, or it may be ground from true madder of the root. The latter may be tested for genuineness with a solution of caustic soda or potash in which it is very nearly soluble. It will not dissolve in dilute ammonia, but cochineal carmine is soluble in this reagent.

Scarlet Lake is usually a composition of cochineal lake and quicksilver vermilion of palest shade in equal parts reduced with their combined weight of alumina sulphate. Here the proportions of pigment and vehicle are 72 per cent. and 28 per cent., respectively.

Venetian Red for this line should be of the brightest type obtainable and be practically pure oxide of iron, ground fine, using 75 parts by weight of pigments to 25 parts by weight of poppyseed or refined linseed oil.

Vermilion for artists' use should be quicksilver vermilion and the grade known as Chinese is the best that can be selected; 86 parts by weight of the dry color to 14 parts by weight of poppyseed oil is about the right proportion for mixing. On account of its heavy specific gravity the pigment separates from the oil in the tubes, and some color grinders have resorted to all sorts of means to overcome this, many using wax with the oil to

keep pigment and oil together, and while they have succeeded, the users have had trouble with the color on account of the presence of the wax. A better and safer plan is to grind the pigment in part poppyseed oil and part bodied linseed oil, such as is used in the grinding of lithographers' ink, when the artists can thin the material with some turpentine for easy flowing without impairing the gloss or life of the color.

Red Colors in Water for Distemper Work.

This list comprises carmine and crimson lake, Indian red, maroon lake, red lake, rose lake, rose pink, Turkey red lake and Venetian red. Since the advent of the numerous cold water paints the demand for red colors in water for use in distemper or fresco work has become very limited, and is confined to red lake, rose lake and rose pink that are used by grainers, and to *Turkey* and Venetian reds used by decorators.

Carmine or Crimson Lake, dry pigments similar to those used in oil color lines simply pulped in water by running through mixer and mill and put up in glass jars is the usual custom.

Indian Red.—One shade, the deep, is sufficient, and 80 pounds pigment mixed with 25 pounds water and run through mill will yield 100 pounds paste.

Maroon Lake.—Color makers supply a pigment of this color, that is, non-bleeding, and may be mixed at the rate of 70 parts by weight of pigment and 35 parts by weight of water, and when run through a mill will yield 100 parts by weight of paste.

Red Lake should be of the permanent type, and it is best to mix 60 parts by weight of alizarine red lake with

50 parts of water, run through mill, until fine. Yield 100 parts paste.

Rose Lake and Rose Pink may be of same type as those described in the oil color list. For the first named about 60 parts pigment and 45 parts water, and for the second 68 parts pigment and 37 parts water will be required for 100 parts of paste.

Turkey Red Lake is usually offered in two shades, light and dark, either of them being of the scarlet azo color type described under oil colors as carmine substitute, and either shade will require about 70 parts of dry color and 35 parts of water to make 100 parts of paste.

Venetian Red in this line should not be of too deep a shade so as not to show up purplish when mixed with distemper color base. Should be more on the terra cotta effect, but, of course, much richer. Does not require to contain over 40 per cent. in sesquioxide of iron; 75 parts by weight of pigment and 30 parts of water will yield 100 parts of paste in water.

Red Colors in Japan or Varnish.

In this list there are colors, the names of which are standard, as they have become familiar to the trade by long usage, while each and every color grinder has his own proprietary name for some of his specialties. As these are not in regular lines we shall not discuss them at length, but simply pick one out here and there as examples, confining ourselves to the description of the well-known materials. These consist of or comprise such as carriage part lake, coach red, carmine, English vermilion, red lake, rose lake, rose pink, road cart red, Indian red, Tuscan red, Venetian red, wine color.

Carriage Part Lake.—The name indicates the use to which this color is assigned. Is not so much in demand as formerly, the maroon toners having taken its place. Still when called for, the pigment selected is a good rose lake of good strength and twice as much crimson lake of the cochineal type above referred to ground in coach japan at the rate of 60 parts dry color to 40 parts japan. The pigments must be bone dry, otherwise the ground color will liver in short order.

Coach Red or Coach Painters' Red.—This brilliant red, made on a base of orange mineral and eosine vermilion with alizarine red lake, is now supplanted by reds of the paranitraniline type, such as the autol fast red, asophor red, helio fast red, as the dyestuffs of recent development are named. The change is really for the better, and whatever fast red is selected is ground in a vehicle of gold size japan and rubbing varnish, and not in the ordinary color grinders' japan, as that would take away too much of the brilliant effect.

Carmine No. 40 or French Carmine.—This brilliant red color, once so much in demand as a glaze, has also been relegated to the rear, but is, however, still found on the coach color lists.

Being used merely as a glaze over ornamenting in orange or vermilion or fast reds on work where cost is not considered seriously, it must be ground exceedingly fine in a pale rubbing varnish, and, as a rule, the proportions are 40 parts by weight of the dry pulverized carmine to 60 parts of varnish, the grinding being accomplished on a water-colored esopus stone mill of a size in proportion to the batch. Carmine being the most expensive material in the line of reds, waste cannot be well afforded.

English Vermilion.—The usual proportion for a grinding is 82 parts by weight of the dry pigment and 18 parts gold size japan. Must be ground on watercooled esopus stone mills of slow speed and great care taken not to have the stones set very tight, as the color is easily ruined by that operation.

Red Lake, Permanent.—Here the alizarine red lake is preferred and a good selection should be made. The dry color should be finely powdered and made bone dry in a suitable heating apparatus, 40 parts by weight of the dry material, 52 parts of hard gum rubbing varnish, pale, and 8 parts turps ground fine on a water-cooled esopus stone-mill will produce a red almost rivalling carmine in fire and distancing it by far in permanency.

Rose Lake or Geranium Lake is hardly ever called for in this line any longer, the coloring matter, constituting these pigments being too fugitive. Fast reds are being used instead.

Rose Pink is often called for ground in Japan when mahogany effect is desired in car work, etc., or in furniture factories, and 70 parts of dry pigment and 30 parts color grinders' japan is the proper proportion for mixing.

Road Cart Red.—This red was made to supply a demand for a red color to be used on low-priced vehicles whence it derived its name. The coloring matter used was of the same type as the azo scarlet or carmine substitute above referred to, mixed with artificial vermilion to give good body or hiding power. At present the low-priced para reds in japan have replaced this red. The better class of these reds is composed of 7 to 8 per cent. pure para red toner with a base of barytes and whiting, 84 pounds of which and 16 pounds color grinders' japan constitute this color.

Indian Red.—The English importation of this is usually preferred here, although there are several manufacturers in the United States who have succeeded in making this artificial oxide of iron; 77 parts by weight of the dry color and 23 parts by weight of color grinding japan is the proportion required for the paste.

Tuscan Red.—While a Tuscan red, made from suitable oxide of iron with a para toner or toluidine red may exhibit quite a degree of permanance, it cannot surpass the material made from Indian red and alizarine red lake for durability and resistance to heat. A mixing of 40 parts by weight of Indian red, containing 96 per cent. sesquioxide of iron, 20 parts by weight of blanc fixe, 12 parts by weight of alizarine red lake, and 28 parts by weight of color grinders' japan, will produce 100 parts by weight of a brilliant Tuscan red of great permanency of color on exposure, decided resistance to heat and not excessive in cost, compared with its value as a body color. For a color of lower price, increase the percentage of blanc fixe and decrease the percentage of lake.

Venetian Red.—In this case a bright red should be selected, one that does not contain less than 35 per cent. of sesquioxide of iron and the pigment well dried before mixing with the color grinding japan, of which about 27 parts by weight are required to produce 100 parts paste in oil with 73 parts of the dry pigment. Must be ground on water-cooled mill to keep from gumming up.

Wine Color.—Some coach painters prefer a lake color of great richness, others desire a color that covers a suitable ground in one coat. The latter is best made with a base of Indian or Tuscan red, adding the necessary claret lake (magenta), grinding in color grinding

japan. A wine color of rich effect cannot be produced as a body color, it must necessarily be transparent or at least semi-transparent. Color makers are now in position to offer fast claret lakes of great strength for this purpose, and it would be idle to suggest using the old line formulas of mixing various lakes.

CHAPTER XII.

MIXING AND GRINDING YELLOW PIGMENTS.

Yellow Ocher.

Yellow Ocher is first and foremost among the yellow pigments because of the great quantities consumed, both in the dry state and ground in oil. Years ago it was thought to be indispensable as a priming or first coater for raw wood on exposed surfaces, such as the frame dwellings and buildings going up all over this country by hundreds of thousands. The experience of many years has brought about a revulsion in the ocher priming practice, and this has been caused by the gradual enlightenment of consumers that it is a fallacy to assume that anything in the paint line is good enough for the priming coat. While that idea was prevalent among the trade, disreputable painters and ignorant consumers were in quest of cheap priming ochers, and many grinders made it a practice to cater to such trade in order to reap a harvest while the sun was shining, and outbid competitors. In order to produce a so-called yellow ocher in paste form at low cost, some ground up French yellow ocher with two or three times its own weight of barytes, thus saving in the cost of linseed oil, and these were not the worst specimens on the market, while others went further in the sophistication principle by mixing the cheapest kinds of domestic ochers with still cheaper whiting, off-colored barytes, marble dust or clay, and grinding such mixtures in part linseed oil and part mineral oil, giving the material a bright effect by the addition of a trifle of chrome

yellow, and such dopes are still made and sold to-day, although the grinder will not at all times place his name upon the package. It stands to reason that material of that description cannot make a foundation for the paint to be applied over it as a finish, and that is one of the chief reasons why priming with ocher has shown itself to be a disastrous failure, on account of its inevitable scaling clean to the wood, if not after the original painting, then surely after the repainting. On such timber as Southern pine, cypress, sycamore, birch or maple, even the best French yellow ocher, ground in and thinned for the purpose with pure raw linseed oil, is unsuitable, unless it is mixed with at least three times its weight of lead carbonate (corroded white lead), while for such lumber as whitewood, white pine, spruce and hemlock, etc., a priming made from finely ground French ocher in sufficient raw linseed oil, used rather thin and well rubbed in, will not be apt to split and throw off the top coatings of paint. Of all yellow ochers, that imported from France is preferred, and the United States Navy Department specifications call for a yellow ocher to equal the best French ocher in color, shade, tone and strength, containing not less than 20 per cent. sesquioxide of iron, not over 5 per cent. of lime in any form, balance to be of the natural gangue that occurs with it in nature, which means silica and aluminum silicates. It will not be uninteresting to note that in France the mining, levigation, drying, etc., of ocher is much more primitive than elsewhere in the world, and yet the cost is comparatively low because of the great area available for the purpose. In England, Germany, Italy and the United States the mined ocher earth must be put through a more or less costly process of milling in the wet, floating, drying in kilns or cham-

bers, sifting, powdering and sorting, while in France the mined earth is spread over an area varying from 3,000 to 6,000 square yards, through which ditches are dug that lead to basins which are arranged over one another. During the summer months all work is stopped. In the fall of the year, during the rainy season, the water runs through the ditches and carries the earth slowly to the next basin. Here the coarser particles sink to the bottom, while the finer portion is floated to the next basin, and so on until all the earth has been well levigated. Throughout the winter, while there is no freezing, this natural floating apparatus does its work, until the whole area is free of the ocher earth and the basins full of it. A few weeks later the basins are drained as much as possible of clear water, and the sun of early spring finishes the evaporation of the remainder. When the yellow earth has dried up so far as to show large furrows it is taken up and spread on trays in thin layers and dried by the heat of the sun, and, this accomplished, it is filled in casks and made ready for the market. The fineness of the floated material makes pulverizing in a mill or sifting apparatus unnecessary. In the marking of the packages the French ocher producers are really practical. Each cask bears a general designation, denoting the quality, as, for instance: Qualité extra superieur (extra fine quality), qualité superieur (fine quality), Ire qualité (good or prime quality). In addition to these general designations will be found on each package such letters as J. L. C. E. S., J. F. L. E. S., J. T. C. E. S., J. O. L. S., and so on. J. stands for jaune or yellow, L. for lave or levigated, C. for citron or light yellow, T. means tres or very, E. for extra, F. for fonce or dark, O. for or (or gold), R. for rouge (or red), M. for mijico, a very desirable shade, so

that these letters give an idea of the sort of ocher contained in the casks, which usually run between 340 and 360 kilos gross weight. Some importers have the French producers mark the casks with such marks as citron, satin, or with the initials of their firm names. These ochers of the pale shade show anywhere from 17 to 22 per cent. sesquioxide of iron, but there is at least one brand of J. F. L. E. S. (dark shade) that analyzes from 26 to 28 per cent. in sesquioxide, and this is usually selected for grinding a brand known as Oxford ocher in oil. Having thus described the trade marks of French yellow ocher, we would say that the color grinder will have no difficulty in selecting his needs by testing the samples offered for shade, tone, fineness and strength in the usual way, making rub-outs or trial grindings. When once a certain brand has been adopted, there is no trouble in obtaining the same quality right along, for as a rule the exporters as well as the importers see to it that the standard is well kept up to the mark. There is not enough margin of profit for either to take any great risks. The precaution necessary in the mixing and grinding of French and other yellow ochers is to see that the material is as dry as possible; in other words, bone dry. Oftentimes it so happens that a cargo in crossing the Atlantic Ocean will become more or less saturated, and the moisture will not evaporate while enclosed in the cask, therefore the ocher should be spread on drying pans or other apparatus suitable to the purpose, because moist or damp earth paints will not mix with the minimum quantity of oil and pass through the mills in lumpy condition, even when an excess of oil is used. At least a good, smooth paste cannot be produced with damp material. For grinding ocher in paste form, any good stone mill of a diameter between 24 and 30

inches, with not too high a speed, will render good service, and for French ocher of good fineness the soft or esopus stones are preferable, while for the more gritty English, Italian and domestic ochers buhr millstones are better suited. French yellow ocher for the general trade, ground pure in paste form, is best mixed 72 pounds pigment and 28 pounds raw linseed oil, and boiled linseed oil should not be used, as it makes the paste too soft, and on standing about in containers the oil is apt to separate. When grinding large batches of ocher in oil into one package, the material in the middle of such package is often found to form hard lumps. This is due to overheating in the mill, or it may be due to moisture in the pigment or in the oil, but can be avoided by using smaller containers, in which the paste may cool more rapidly and then be dumped into the larger package, or by having the paste run from the mill into a mixing can with stirring device.

The color in oil sold by reputable manufacturers as French ocher or French yellow is that which is ground from the J. L. C. E. S. or citron brand, while the satin brand is also favored to some extent. *Special* brands of *Yellow Ocher in Oil,* when pure, i. e., without any extending material, are either made from the best grades of Pennsylvania mines, which are not so high in iron oxide, but of fairly good color, some of them approaching second or third grade French ochers in point of color and requiring about 75 per cent. of pigment to 25 per cent. of oil by weight to form a good paste. When, however, prices of the dry ochers are compared and percentage of oil required is considered, it will be found that the small difference in cost does not warrant the color grinder to place such a brand on his list as

yellow ocher without the prefix "French," because he cannot obtain a high enough price. The Southern ochers, mined in Virginia, Georgia and Alabama, are usually very high in oxide of iron, some running as high as 64 and even 72 per cent., but their color is exceedingly dull, and the demand for them is limited to the use in backing up floor oilcloth and as an oxide of iron filler in certain specification paints for railroads, and also to furnish the necessary oxide of iron feature in doped brands of ocher.

Golden Ochers and Chrome Ochers in Oil.

There is no standard in the trade for true or genuine, that is, unadulterated golden ocher or chrome ocher, and every color grinder has his own standard or else matches his competitor's brand. As an example of a formula for a pale or light shade of golden ocher, we would suggest 65 parts of J. L. C. E. S. French ocher, i. e., the pale citron shade; 7 parts by weight of a clear shade of medium chrome yellow, and 28 parts by weight of clarified or refined linseed oil, for 100 parts of paste. Lemon yellow should not be used, as it would make the color too flat-looking, too sad, as some would term it. For a dark or deep shade of golden ocher, would suggest 65 parts by weight of J. F. L. E. S. French ocher (dark shade) and 7 pounds of a light shade of orange chrome yellow with 28 pounds raw linseed oil, grinding the mixings in either case on same kind of mills as French ocher. For convenience and prevention of waste, when small batches only are to be produced, we suggest the following formulas:—For light golden ocher in oil, mix in a

suitable mixing can and beat up until smooth and free of streaks, 90 parts by weight of French yellow ocher in oil and 10 parts by weight of medium chrome yellow in oil. For the dark golden ocher follow same proportions, but use J. F. L. S. ocher in oil and orange chrome yellow in oil, that must be perfectly free from paint skins in either case. *Chrome ocher*, when expected strictly pure in oil, is only another name for golden ocher, and our formula for light shade will answer here, because it should be made only by the addition of neutral lead chromate, not the basic chromate of lead to ocher. When bought in quantity chrome ochers are not expected to be pure ocher and chrome yellow, but a sort of golden ocher with a marigold tint. The usual selling price for this material is not above, but rather below, that of the pure French yellow ocher in oil, and the goods sold under the brand chrome ocher are really imitations of golden ocher. At least, the various analyses had of specimen samples would show this. The best of the samples analyzed could be matched very close in color, tone, strength, etc., by mixing 17 parts J. L. C. E. S. ocher, 3 parts medium chrome yellow, 1 part Venetian red, 12 parts whiting, 50 parts floated barytes, and 17 parts raw linseed oil, for each 100 parts of medium soft paste. This analysis came fairly close to the result from the analysis of an imitation of golden ocher sold in dry powder at a fairly low figure. On the strength of the foregoing it will not be difficult for any grinder of experience to formulate mixings and grindings of yellow ocher for the consumer's requirements, and so long as he does not practice deception by using deceiving terms no one can take exception to the class of goods he makes for his patrons.

Yellow Oxide.

Yellow Oxide in Oil will also be found in the oil color lists of some manufacturers, but the demand is rather limited. There are some very pretty yellow oxides offered to the trade from English and Italian sources, and there is a limited quantity found in this country. Color grinders use yellow oxides to strengthen ochers that are listed under fancy names; also to mix with raw sienna. The percentage of oil required for grinding yellow oxides varies to some extent, the English variety needing 30 pounds oil to 70 pounds dry pigment, while Sardinian yellow earth (oxide) requires 38 to 40 pounds of oil for 60 to 62 of pigment. Very bright yellow oxides are very useful in making pigment stains, as well as for tinting. In that case and when wanted for that purpose they should be ground very fine in strong boiled oil.

Chrome Yellows.

Next and of not less importance in the line of yellow pigments are the *Chromate of Lead Yellows*. Here we have the pale or light shades, usually designated as lemon, citron or canary yellow, then the medium or, as the English call it, middle chrome yellow, which is or should be the neutral or normal lead chromate, and which is sometimes deeper, sometimes lighter, according to the luck the color maker has in perfecting the batches; then comes the deep or orange chrome yellow, to which some color makers add another darker shade which they term D. D. chrome or D. orange chrome yellow. When it comes to the very deep orange shade, the output of these varies with almost every color maker's product. The pale shades, that are designated as canary, citron,

lemon or primrose yellow, according to their tone, vary to quite an extent, even when pure, in strength as well as in their absorption of oil on grinding, and we have noted formula labels on cans of pure lemon chrome yellow where the percentage given was 86 per cent. pigment to 14 per cent. oil. If correct, this statement would indicate that this yellow, although free of adulterants in the strict sense of the term, contained an excessive portion of lead sulphate, probably basic lead sulphate in the form of added sublimed lead. A normal basic chromate of lead of the lemon or primrose shade should not contain over 40 per cent. of lead sulphate, which is necessary, in connection with the bichromate of potash or soda, to produce the pale shade, while a canary shade may contain more. The percentages of pigment and oil in these should not vary more than 2 or 3 points; in other words, 77 to 80 per cent. pigment and 20 to 23 per cent. of oil should constitute a good, workable paste. The oil used in mixing and grinding should be bleached or clarified, and the color grinders in selecting the dry yellow should guard especially against the use of any that contain any portion, no matter how small, of alumina hydrate; which is used in the chrome yellow for printing ink and wall paper printing successfully, but causes trouble by livering for the painter. Other points to be considered are that the yellow selected is of good tone, as rich as may be had, soft in texture and of standard strength, most of it being used for tinting or mixing with other pigments, as, for instance, in greens, where the medium chrome yellow would produce too much of an olive effect. This is obvious when it is known that the chrome greens are mixtures of lemon chrome and Prussian blue, as these could not be obtained by mixing the medium chromes with the blue.

Medium Chrome Yellow in oil is most used in point of quantity by the general painting trade, on account of its great tinting power and brilliant yellow color. The various brands of chemically pure medium chrome yellow vary to quite an extent in these points, although there has been a general improvement all along because of competitive tests made by master painters' associations and by the salesmen representing the manufacturers. The color grinder, who at the present time places second or third grade of this yellow on the market to supply a demand for low price, is not afraid to let this fact be known, and the consumer is not kept in the dark although there may be some exceptions. The extending material for medium chrome yellow in such cases would be principally barytes, although whiting, gypsum, clay or floated silex may be used, so as to give bulk. The oil, when quoted as at present, being not much more than one-half of the cost of the pure medium yellow, does not cut so much of a figure as it did a few years since. The proportions for mixing and grinding a normal medium chrome yellow in oil should be 74 per cent. by weight of dry pigment and 26 per cent. by weight of bleached or clarified oil, but when raw linseed oil is specified as the vehicle it may require 28 per cent. of oil, and under certain conditions, as, for instance, in the case of a very fluffy yellow, 30 per cent. of oil and 70 per cent. pigment will still produce a paste that cannot be condemned as too liquid. When the color grinder intends to supply a demand for "extended" or "stretched" medium chrome yellow, a 40 per cent. article would still produce a paste that, when thinned for a body or trimming color, will cover up solid in one coat over the right ground. A good formula for this is as follows:—Thirty pounds chemically pure medium

chrome yellow, 45 pounds finest blanc fixe, 25 pounds clarified oil. Another, showing more strength in tinting, fair body, but not as good spreading capacity as the former, is:—Thirty pounds chemically pure medium chrome yellow, 52 pounds floated natural barytes, 18 pounds clarified oil. Still another, more bulky than the last, lower for cost, but of less strength and hiding power, is as follows:—Twenty pounds medium chrome yellow, 30 pounds bolted china clay (best English), 30 pounds floated barytes, 20 pounds bleached linseed oil. This may look like a very cheap dope, but it is really good for solid painting, alongside of some of the medium chrome yellow that has been found from time to time on dealers' shelves. The formulas here given no grinder need be ashamed of, when low-priced goods are demanded; it is only the deception that has been practiced years ago that creates suspicion of improper business practices. In selecting his dry medium yellow the color grinder looks for richness of tone, fineness, softness of texture, and, above all, tinting power, and it is really a matter of indifference to him whether the pigment is a nitrate or an acetate of lead yellow, or whether it is made with bichromate of potash or sodium bichromate. Exposure tests of yellows made either way in comparison with one another have shown very contradictory results, and it looks very much as if the permanency of the yellow to strong light or atmospheric conditions depends to a great extent on the mechanical side of the process, i. e., the proper way of treating a batch from end to end, temperature of the water, and the final washing of the color. The color grinder, too, must guard against overheating of the yellow in mixing and milling, and select mills of slow speed for this pigment.

Orange Chrome Yellow in Oil is in fair demand, but mostly that of the light shade, that is, next in depth to the medium yellow. The yellows of this type take the least percentage of oil for grinding of all chrome yellows, and the darker the shade the less is the percentage of oil required in the grinding. Thus, while a rather pale shade of orange chrome requires 20 pounds oil to 80 pounds pigment, a neutral shade requires only 18 pounds oil to 82 of dry color, and in the dark shades of orange it runs from 15 to 17 pounds of oil for 83 to 85 pounds dry color, when chemically pure color is considered. As for the extended brands, the same method for reducing cost is suggested as that for medium chrome yellow. There is a demand for body colors of these types, and on account of the necessity for frequent repainting, because of the darkening of the yellow by the sulphur gases in the air, etc., those favoring the color do not care to pay for chemically pure material when this will do no better than the extended material and probably not as well. Magnesium silicate (asbestine) also suggests itself as an extender, but as it is always slightly alkaline it had best be omitted in paste containing yellow of the lead chromate type, which is very sensitive to the action of even weak alkalies. When grinding bases with chrome yellow, be it light, medium, dark or dark orange, for dipping paint for implement or wagon work, it is best to use as much zinc oxide as the shade is able to stand without losing its yellow or orange effect, and as much pure whiting (that is previously tested with litmus paper for alkaline reactions) as possible, and a moderate portion of china clay of fine quality. Here is a formula for a paste that has given excellent results when thinned with ordinary painters' naphtha (62 per cent. benzine) and benzine drying japan:—Fifteen

pounds dark chrome yellow (orange), 5 pounds American zinc oxide, 40 pounds Cliffstone bolted whiting, 20 pounds English china clay, and 20 pounds raw linseed oil, ground fine on esopus stone mills of 30-inch diameter.

Paste Yellows in Oil for the implement and wagon manufacturing concerns, for both dipping and brush work, are not based, as they used to be in the past, on French yellow ocher tints, but are now so standardized that only chrome yellow of light, medium or dark shade can be employed in coloring the white base, that may be lead carbonate and zinc oxide or basic lead sulphate (sublimed lead) and zinc oxide extended or zinc lead, leaded zinc or lithopone, although the last named must not be used in connection with lead chromate. These bases are, as a rule, made to match a standard sample or to specifications, and therefore it is scarcely worth while to give more than one specimen formula here. Such a one is as follows:—Twenty-five pounds dry white lead or sublimed white lead, 25 pounds zinc oxide white (American), 25 pounds English Cliffstone Paris white, not over 5 pounds chrome yellow, ground to a medium paste in 16 pounds raw linseed oil of best quality and 4 pounds turpentine drier.

Zinc Yellow.

Permanent Yellow is a favorite label for zinc yellow or zinc chromate in oil, although baryta yellow or strontia yellow is also considered permanent. Zinc yellow when it first appeared upon the American market was held very high in price, and was therefore rather rarely found in the list of oil colors, but more on the artists' color and coach color lists. It is still anywhere from 25 to 35 per cent. higher in cost in the dry state than lemon

chrome yellow. The color grinder will test zinc yellow for clearness of tone, softness of texture and tinting power although it is seldom, if ever, used for the latter purpose. A fine quality of zinc yellow must not be harsh when rubbed up in oil with the spatula, as that would show that it is liable, after grinding in oil and put up for the market in containers, to become grainy. Pure zinc yellow will require anywhere from twenty-two to twenty-four parts by weight of bleached or clarified linseed oil to from seventy-six to seventy-eight parts by weight of the pigment, which must be bone dry, as moisture will prevent the production of smooth paste. Modern scientific research has discovered that pure zinc chromate ground fine in linseed oil and reduced to brushing consistency with linseed oil and pure turpentine drier prevents, when applied to rust-free iron or steel, the formation of rust or corrosion through galvanic action or atmospheric influence.

Naples Yellow.

Naples Yellow is a lead compound that has been superseded by the lead chromates, but is still now and then called for, but mostly in tube colors and coach colors. True Naples yellow is still sold by a few New York importers in two shades—light and dark. We shall refer to this pigment in considering artists' colors. It has also been known as antimony yellow. When imitation of Naples yellow is desired for use in quantity the light shade is made by tinting pure white lead with lemon chrome yellow, a very delicate cream color, and the dark shade by using a yellow-toned raw sienna and a trifle of chrome yellow to produce a clear buff tint.

Indian Yellow and Cadmium Yellows have no place in the list of ordinary oil colors, and will be dealt with in the description of artists' tube colors and coach colors. *Aureolin* belongs in the same class. *Orange mineral* may be classed among the yellow pigments, though it is really more of a bright red. French orange mineral branded Tours is in lead oxide what French process zinc is in comparison with American process zinc. Instead of hardening in short order like ordinary red lead, orange mineral in oil keeps in buttery condition when ground in linseed oil to paste form, and that made by the French process excels in that respect German process orange mineral or English orange lead. While ordinary red lead requires nine or ten pounds of oil to ninety or ninety-one parts pigment to form a paste, orange mineral requires from thirteen to fifteen pounds of linseed oil to from eighty-five to eighty-seven pounds of pigment for one hundred pounds paste in oil. Orange mineral is favored by many bulletin sign writers for use in place of the darker orange chromes because of its greater body or hiding power.

Mixing and Grinding Yellow Colors for Artist's and Decorators' Use.

In these lists will be found yellow ocher, Roman ocher, Oxford ocher, golden ocher and probably Mars yellow, so far as earth colors are concerned. The ocher designated as yellow ocher is invariably of the French variety and the citron shade usually favored. It is best for the grinder to select only material of very finest levigation for use in this line; that is, the ocher should be entirely free of grit. In that state of fineness at least thirty-two parts by weight of poppyseed or nut oil is required to grind sixty-eight parts by weight of pigment.

Roman Ocher should have a sort of marigold tint or tone and the strong and dark French ocher, branded J. F. L. E. S., say sixty-six parts by weight and two part by weight of bright Italian burnt sienna mixed with thirty-two parts of poppyseed or nut oil ground fine in a stone mill will answer for this.

Oxford Ocher—It is optional here whether the strong dark French ocher, J. F. L. E. S., or an English or German ocher of even greater strength is used so long as the pigment is free of grit and of rich, deep yellow color. The quantity of oil in one hundred pounds paste should not exceed one-third of the total weight of the mixture.

Golden Ocher.—The artist when painting a picture will rarely, if ever, place on his palette a golden ocher that is made by mixing yellow ocher and chrome yellow, but the decorator is not so exacting, and will use that which is ready prepared to save him the trouble of doing his own mixing. There being no rule or standard as to the percentage of yellow ocher and chrome yellow, the grinder can refer back to the formulas given in the regular oil color list, with this precaution, however, that only the finest levigated materials be mixed and ground, and that in place of raw linseed oil poppyseed or nut oil be used, increasing the percentage of oil somewhat over that given in those formulas.

Mars Yellow is really an artificial ocher, but seldom met with nowadays. We are not going far astray when we say that the rich yellow oxides mentioned in the description of the yellow pigments for yellow colors in oil for the general trade are selected for this pigment, and really, when well levigated, so as to be entirely free from grit, are far better in regard to permanency of color

and durability than the artificial product. Like the ochers, it must be ground in poppyseed or nut oil, fairly stout, to avoid separation of oil and pigment when filled in collapsible tubes. Thirty parts of oil to seventy parts pigment is the proper proportion for mixing and grinding.

Naples Yellow is used by artists in oil painting and favored for its great opacity. There are two shades only—pale and deep; any other, and especially that of a reddish tone, is a mixed pigment. Naples yellow, or antimony yellow, is produced by the calcination of the oxides of lead and antimony with access of air in muffled furnaces. This pigment requires for a fair paste fourteen to fifteen parts by weight of oil to eighty-five or eighty-six parts by weight of pigment, and should not come into contact with metallic iron or zinc, as it is apt to assume a grayish tinge.

Chrome Yellows in any shade, from canary to orange, are ground in poppyseed oil for artists' and decorators' purposes, and only the best and cleanest goods that are obtainable should be selected. The proportions of pigment and oil given in our description and suggestions for the regular oil color list apply here, with the exception that in place of using bleached or clarified linseed oil poppyseed or nut oil is to be employed, and the grinding so perfectly done that the oil will not readily separate from the pigment when the color is squeezed from the collapsible tube. Where the output warrants it roller mills are most practical for grinding chrome yellows for tube color.

Permanent, or Zinc Yellow, as noted above, is a chromate of zinc produced by digesting one hundred parts zinc oxide in a great quantity of water with sixty

parts sulphuric acid, to which mixture is added a solution of one hundred parts bichromate of potash. However, *Barium Chromate and Strontian Yellow* are also sold as permanent yellow, and in some instances, as ultramarine yellow. Zinc yellow requires twenty-eight parts by weight of poppyseed oil to seventy-two parts of the dry powder for one hundred parts paste in oil. Baryta yellow (barium chromate) and strontia yellow (strontium chromate) require very close to the same proportions of oil and dry powder.

Cadmium Yellow, known, in short, as cadmium, is a compound of the metal cadmium and sulphur, and is on the market in three or four shades—pale, medium, deep and orange. The darker shades are very permanent to light and unaffected by gases, but the very pale shade is not pure cadmium, containing zinc sulphide or zinc oxide in addition. Pure cadmium yellow dissolves in a strong, warm solution of hydrochloric acid to a clear liquid while giving off sulphuretted hydrogen. If cadmium yellow is mixed with chrome yellow it will show the formation of the black sulphide of lead when treated with sulphate of soda solution. Cadmium yellows should be ground in stone mills with scrapers of bronze, as contact with iron or lead is harmful to its brilliancy, tending to produce dark streaks in the color. The proportions of oil and pigment for grinding the color for tubes are similar to that of the chrome yellows of same shade.

Gamboge is a resin and requires a special treatment before it can be mixed with oil for artistic painting, consisting in powdering the brittle material and extracting the pure resin from the material with alcohol, decanting the clear yellow alcoholic solution, evaporating the

spirit and melting the residue in oil sufficient to make it viscid enough to fill in tubes. Used by artists for glazing, but not permanent to light to any degree.

Indian Yellow, or Purree, a magnesium salt of euxanthic acid, comes into the European market from East India in lumps of the size of a fist, that are of brown color on the outside, but of a bright yellow inside, and have the odor of ammonia rather strongly. When the outer crust is taken off and the yellow well washed in boiling water and ground in borate of manganese oil it is a very permanent yellow color for use of artists, while for other purposes it is too expensive. On account of its high market price it is susceptible to adulteration with inexpensive yellow lake or Dutch pink, sometimes chrome yellow. The presence of yellow lake or Dutch pink can be determined by disintegrating the pigment with hydrochloric acid and then adding ammonia in excess. If pure a bright yellow, clear solution is had; but if yellow lake or Dutch pink is present there will be a precipitate of alumina or hydroxide of tin. There is an imitation of Indian yellow on the color market that has even a better and richer tone than Purree, but, being a coal-tar derivative, it is not as permanent. However, its price is only one-fourth as much as that charged for the true article. True Indian yellow requires for one hundred parts of finished tube color in oil, fifty-six parts pigment to forty-four parts of poppyseed or linseed oil that has been boiled with 2 per cent. of manganese borate. Imitations of Indian yellow differ somewhat in the percentage of oil required, but a sample tested by the author required four parts by weight of poppyseed oil to six parts by weight of pigment.

Yellow Lakes are uncertain pigments, and the only one suited for the use of the artist is that branded as *French Superior Yellow lake in drops.* This is made from the extract of the quercitron bark on a base of alumina hydrate, which has a tendency to make the color liver in time, and it should be guarded against, even at the expense of brilliancy, by selecting yellow lake with a base of alumina sulphate. This is a matter that can be arranged mutually between the color maker and the color grinder. In grinding yellow lakes the utmost fineness must be attained, as the color is used for glazing, and the finer it is ground the better the transparency. Usually fifty-eight pounds pigment and forty-two pounds poppyseed oil are required for one hundred pounds of the color in oil, but these percentages will differ materially, according to the nature of the base.

Dutch Pink, Italian Pink, yellow madder and brown pink are simply very much extended yellow lakes, and are used for scene painting, the base material taking away the transparency to a great degree, also making the pigment less oil absorptive.

Aureolin, or Cobalt Yellow, is a complicated salt of the metal cobalt and has no advantages over other yellow pigments, and, as it is rather high in cost, is seldom used. Requires six parts of oil to four parts of the dry color on mixing and grinding. Usually the name Aureolin appears only on the label and in the color lists, but the color in the tube is usually another rich yellow pigment.

King's Yellow, or Orpiment, an arsenic sulphide pigment, is now practically obsolete, and when found in tubes as an artists' and decorators' oil color it will be discovered to be medium chrome yellow.

Mixing and Grinding Yellow Pigments in Water.

French or Yellow Ocher is in fair demand for tinting kalsomines and for fresco or distemper work in general. For this purpose the citron shade, J. C. L. E. S. of French ocher is preferable, and sixty-five parts of the dry pigment, well mixed with forty parts water and then run through a good stone mill, will produce 100 parts of paste, to be put up in the usual way in glass, or, if required in quantity, in earthen jars or wooden kegs well sized inside. Tin pails are not well adapted for this class of goods because of the formation of rust.

Golden Ocher, both pale and deep, are also found in lists of distemper colors, being useful in producing the richer yellow tints. For the pale shade, the citron ocher, say fifty-seven parts, eight parts of pale medium chrome yellow and forty parts water, will produce 100 parts of paste, while for the dark shade, fifty-five parts of strongest J. F. L. E. S. ocher, ten parts of a light shade of orange chrome yellow and forty parts water will result after grinding in the production of 100 parts paste.

Dutch Pink, English Pink or Italian Pink, under whatever name it may be called for, is also very useful as a water color, for the reason that it enables the decorator to obtain effects that he cannot produce by the use of ocher or raw sienna in composite colors, while yellow lake would prove too expensive. The percentages of pigment and water required for mixing and grinding Dutch pink depend very much upon the base on which the dyestuff is precipitated, but figuring on sixty parts pigment and forty-eight parts water for 100 parts paste will prove a safe average.

Chrome Yellows, light or lemon, medium, dark or orange, are also in fair demand, and when a color making establishment is connected with a color grinding factory it is, of course, a decided factor in economy to place the pulp from which all but say 35 per cent. of the water has been removed by settling or pressing on a mill to give it one, or at most two, runs in order to break up any little particles that usually form when the yellows are precipitated. Thirty-five per cent. by weight of water would be the average in the pulp, and this will mean about 40 per cent. for the medium, but not over 30 per cent. for the light, or lemon, and dark, or orange, shade. However, the color grinder who does not have a color making department connected with his plant will mix the dry yellow in water and run it through a soft stone mill until the paste is fine and of proper consistency. These pigments, being rather heavy, are apt to settle when ground with excess of water, hence it is necessary to scoop off the surplus after permitting the finished goods to set over night. For the light and dark shades seventy parts dry pigment and thirty-five parts water, and for medium chrome yellow sixty-five parts dry color and forty parts water, should, when ground, render 100 parts paste in each case.

Permanent Yellow or *Zinc Yellow* is fairly important in the line of distemper colors and should be found on the list. The proper proportions for 100 pounds of paste in water is to mix seventy-six pounds dry color with thirty pounds clear water and run through a clean stone mill.

Aureolin or *Cobalt Yellow*, being partly soluble in water, should be omitted from the list of water colors.

Cadmium Yellow is too expensive for use in this connection, therefore not called for by the trade.

True Naples Yellow is not used in distemper painting.

Mixing and Grinding Yellow Colors in Japan.

The yellow colors for coach and car work that are listed under the caption of *Superfine Coach Colors*, as a rule, are not necessarily ground in what is understood as japan, but may be ground in the brown siccative known as color grinders' or coach painters' japan, in gold size, rubbing varnish, finishing varnish or in part oil, turpentine, etc. The meaning of the term "in japan," which is collective for a group or type of colors in paste form is that when reduced to brushing consistency and so applied to the proper surface, they will dry quickly to a more or less "matt" or flat surface that is to be coated with one or more applications of varnish.

There are any number of yellow colors of this type, so far as the vehicle is concerned, and they run with fanciful names from the palest cream yellow tint to the deepest orange. As most of them must be produced to match certain standards adopted by consumers we will confine ourselves to the description of those found in almost every color grinders' list, adding a few formulas for attractive car colors.

French Ochers in Japan.—It is, of course, optional with the color grinder whether he prefers the light citron shade or the dark shade of the J. F. L. E. S. superior quality of French ocher. The vehicle in this brand is usually color grinders' brown japan, that should be tempered with at least 5 per cent. of raw linseed oil, and, if the japan is of the very quick type, 10 per cent. oil

would not be excessive, because ocher is a brittle material at best. We suggest a mixing of sixty-eight pounds of bone dry ocher, thirty-two pounds color grinders' brown japan and three pounds raw linseed oil, to be ground fine on a water-cooled mill, well sharpened, which should result in producing 100 pounds finished color.

Golden Ocher in Japan.—The pale shade of this is a favorite with railroad equipment painters for lettering and ornamenting on cars and engines when gilding, for some reason or another, is not desired. It is made, as a rule, by mixing sixty-two pounds of J. C. L. E. S. ocher, eight pounds medium chrome yellow of pale shade, thirty pounds color grinders' japan and three pounds raw linseed oil, resulting in 100 pounds finished material.

The dark shade, which is more seldom called for, is made by mixing sixty pounds of J. F. L. E. S. ocher, ten pounds orange chrome yellow, light shade, thirty pounds color grinders' japan and three pounds raw linseed oil, producing 100 pounds color, when ground fine.

Imitation of Gold in Japan is usually bought in one-fourth-pound collapsible tubes, but most coach painters mix their own color from flake white, chrome yellow and vermilion red, with perhaps a little ocher thrown in. Mix eighty pounds finest quality dry white lead, eight pounds medium chrome yellow, two ounces toluidine red (fast scarlet toner) with two and one-half pounds gold size japan, seven and one-half pounds pale rubbing varnish, two pounds refined linseed oil and four pounds turpentine and grind fine on water-cooled mill. Produces 100 pounds paste that will answer very well for lettering and striping. If not warm enough in tone, add more red.

Dutch Pink in Japan is not called for very frequently, probably on account of the coach painters' custom of purchasing composite greens and other colors of this type that contain this pigment ready ground. Still it should be on the coach color list, under either this name or as English or Italian pink. But as it should serve as a glaze over greens or olive tones it should be ground in a pale vehicle to impalpable fineness and the pigment selected should not have a base of whiting, but of alumina sulphate. Mix seventy-two pounds dry color with either pale gold size japan to make 103 pounds or a mixture of twenty-six pounds pale rubbing varnish, three pounds raw linseed oil and six pounds turpentine, resulting in 100 pounds finished color in either case when ground on a good water-cooled stone mill.

Chrome Yellow in Japan.—Canary, lemon and primrose yellows are pretty much the same type of chromes, differing slightly only in shade, but more in tone. Canary yellow is cleaner and paler than lemon yellow, while primrose is also cleaner and paler, but more greenish in tone than lemon. The most successful vehicle for use in grinding any chrome yellow has been found by the author to consist of eighty-two parts by weight of pale hard-drying rubbing varnish, six parts well clarified raw linseed oil and twelve parts pure gum spirit of turpentine. In place of the rubbing varnish a pale hard picture varnish of twelve hours drying will also answer. We shall refer to this as yellow thinners. To mix either the color for primrose, lemon or canary yellow use eighty pounds of the dry color and twenty-four pounds yellow thinners to obtain 100 pounds finished color.

Medium Chrome Yellow in Japan requires more vehicle than either light or dark shades, and, while the bulk of this yellow varies somewhat, it is safe to say that seventy pounds dry color mixed with thirty-three pounds yellow thinners will, when carefully ground on suitable soft stone water-cooled mill, render 100 pounds finished product.

Orange Chrome Yellow in Japan, normal or dark, is not quite as dense as the lemon shade and therefore requires more thinners to manipulate in mixer and mill. Seventy-six pounds dry color and twenty-eight pounds yellow thinners will produce 100 pounds finished color.

Cadmium Yellow in Varnish.—This sulphur compound is stable only in its darker shades—that is, the normal or medium and the dark or orange and deep orange, if such is offered. The pale and light shades contain other metals such as tin and zinc and are prone to fade in strong light. Inasmuch as cadmium is high in cost, it will not pay the grinder to experiment a great deal, and he had best confine himself to the two shades M. and D. Cadmium yellow in varnish being used as a finish or glaze color over other yellows, it cannot be ground in japan, but must be mixed with a hard gum pale finishing varnish with enough turpentine to grind well. The vehicle should be an article made from selected XXXX kauri gum with twenty gallons oil to the 100 pounds of gum, thinned with pure gum spirits of turps only. Figure on seventy-six parts of dry cadmium yellow M. or D., twenty-four parts of varnish and five parts turpentine for 100 pounds finished color. This color must not be put up in collapsible tubes or in tin or iron containers, but is usually put up in glass jars, mostly one-pound size, otherwise the color tends to blacken.

Permanent or Zinc Yellow, also sometimes branded *Perfect Yellow,* is used but little in coach work, due probably to prejudice on account of its zinc constituents. Is used for ornamenting on sleighs and automobiles, however, and is best ground in the yellow thinners above referred to, requiring twenty-six pounds thinners to seventy-eight pounds dry color for 100 pounds finished color. In grinding all these yellows, overheating of mixer and mills must be guarded against and cadmium yellow especially must not be ground in an iron mill, and even a stone mill must not have an iron scraper and steel spatulas must not be used.

Naples Yellow in Japan.—True Naples yellow is rarely looked for and is usually imitated with ninety-five pounds flake white and five pounds golden ocher in japan. However, the true article is still obtainable and the price of the dry material is not extraordinarily high. While it requires more thinners than white lead, it is, if anything, denser. Eighty-six parts of dry pigment and sixteen pounds yellow thinners will make 100 pounds of paste of either shade, A or C, which are the marks for light and dark, as sold in the market.

Sulphur Yellow or Brimstone Yellow in Japan.—These are simply white lead tinted with either lemon chrome yellow or zinc yellow, according to the depth of shade desired. For the light shade two pounds zinc yellow and eighty-seven pounds fine white lead and about twelve or thirteen pounds yellow thinners; for the dark shadow two pounds lemon chrome yellow to eighty-seven pounds white lead and twelve or thirteen pounds yellow thinners will be sufficient for 100 pounds finished color.

Citron or Citrine Yellow in Japan is made from a mixture of eighty-six parts white lead and three parts lemon chrome with a trifle of ultramarine blue or green added to give the greenish cast, grinding in twelve parts yellow thinners to produce 100 parts paste.

Car-Body Yellows in Japan.—These are ground to match the standard specified by the owners, but very seldom consist of straight chrome yellow in japan. The base is almost invariably basic carbonate of lead (white lead) and the coloring matter may be lemon, medium or orange chrome yellow and sometimes French ocher or any admixtures of these. A light car-body yellow much used by certain street railways is made as follows:—Forty-two pounds dry white lead, forty-two pounds dry lemon chrome yellow, mixed with eighteen pounds yellow thinners as noted above. Produces 100 pounds paste color in japan. A medium car-body yellow known to the author is based on this:—Forty pounds white lead, dry, twenty-five pounds J. C. L. E. S. ocher, fifteen pounds medium chrome yellow, mixed with and ground in twenty-two pounds yellow thinners, producing 100 pounds of color of great covering power.

Omnibus Yellow in Japan, made with thirty-five parts white lead, dry, thirty-five parts orange chrome yellow, D., ten parts dark Venetian red, dry, twenty-two parts color grinders' japan, producing 100 pounds of an orange maroon color of very good body.

PART III.

PAINT VEHICLES AND THINNERS.

CHAPTER XIII.

LINSEED OIL.

So far linseed oil has not found an equal in paint making, although the subject has been one of deep study, and while other fixed oils have been discovered, that for certain purposes have been expected to take its place, it has yet to be demonstrated, that such is really the case in long practice. China wood or tung oil, while superior to linseed oil in certain directions, especially in its resisting power to water, has not shown itself adapted to replace linseed oil in making oil paints, as we know and desire them. As we go along in the consideration of other paint oils, we will show the reasons for this. To go into the technical study of linseed oil and its chemistry would be a waste of time and space here, because it would simply be a useless repetition of what has been written on the subject by eminent students in its chemistry. To those, who wish to go further into the characteristics and chemical composition of linseed oil, the writer would refer to the following works as being standard on the subject: "Linseed and Other Seed Oils," by William D. Ennis, M.E. a very complete American treatise; "Drying Oils, Boiled Oil and Solid and Liquid Driers," an English translation from the German of Louis Edgar Andes.

The practical paint maker and color grinder, however, need not consider linseed oil for any other purpose but that of getting the best and purest as well as that, which is of a quality giving the results he is striving for.

If he deals with a reputable crusher of linseed oil and carefully checks up and examines deliveries, he need have no anxiety about the effect of the oil upon his products, but it is also up to him to exercise the utmost care and watchfulness to have his storage tanks cleaned out at regular intervals, because even the purest and most well settled oils will, in time, deposit a slimy substance known as oil foots and when this is permitted to accumulate, it will cloud the oil, when the contents of the tank become agitated from any cause. Many a batch of color or paint has gone wrong and the cause could not be traced to the proper source, because of the stereotyped excuse, that the formula was followed to the letter and the oil was the same as had always been used. Yet the trouble of improper drying or inferior binding properties of the material might be directly traced to oil foots. In the case of boiled oil this is even worse, as it stands to reason, that the litharge and manganese, after having given up their oxygen to the body of the oil, are still in fine division and on settling drop to the bottom of the storage tanks as a useless slimy mass, carrying with it some of the glycerides, that are broken by the boiling process. This refers to the kettle or fire boiled oil. But in the present day process of boiling oil, where the oil is only heated to a high enough temperature to expel moisture and a cheap lead or manganese resinate drier is introduced in liquid form, it is still more necessary to be on the lookout for precipitated matter.

As to the purity of linseed oil, the best precaution is to purchase supplies from reliable crushers or their agents only, who will not sell sophisticated linseed oil in any form. As to detection of adulteration in linseed oil,

there are a few very simple tests. In the first place, a standard gallon of 231 cubic inches must not weigh less than 7¾ pounds, when oil shows a temperature of 60° F. Ordinary boiled linseed oil should weigh 7 lbs. 13 oz. to 7 lbs. 14 oz., while heavy bodied linseed oil (oxidized oil) may weigh anywhere from 7 lbs. 15 oz. to 8 lbs. 2 oz. per gallon. When linseed oil is placed on a strip of glass, that has been painted jet black, and shows a bloom or iridescence, it is doctored either with mineral oil or rosin oil, which can be determined by the characteristic odor. Admixtures of linseed oil and corn oil or linseed oil and cottonseed oil can be detected, by placing some of the oil between the palms of the hands, rubbing briskly and noting the odor thus emitted. Fish oil in admixture with linseed oil is readily detected by its odor, which cannot be disguised. The presence of soya bean oil, however, cannot well be ascertained by simple tests and a chemical analysis is necessary and sometimes misleading at that.

CHAPTER XIV.

CHINA WOOD OR TUNG OIL.

A General Description of Its Origin, Production, Physical and Chemical Properties and the Great Importance of Its Use in the Manufacture of Varnishes.

Origin.

It is generally known that this oil is pressed from the fruit of a tree which is named by the Chinese, on account of the bottle-shaped form of the nuts it bears, tung yu or ying tzu tung, also tung tze chou, hence the name tung oil, and because of its home being China, we have the commercial term China wood oil. A similar oil, which the Japanese term Dokuye-no-Abura, is produced in Japan from trees named Abura-no-ki, Abura yiri and Yama girl, and all of these trees, including the tung tree of China, belong to the groups that are known by the botanical names Aleurites cordota and Aleurites Fordii. It has been contended by some botanical authorities that the last named is the mother plant of all and that from its fruit the best oil is produced, but this has yet to be proven. At any rate, the China wood oil, as it is imported into this country from Hankow, has always had the preference over that obtained from other sources.

The tung tree and its products have found many varied uses for centuries past in its home. The Chinese hold it in the greatest esteem on account of the many benefits derived from it. The wood of the trunk of the tung tree, while it is still young, is white and soft, but as

it grows becomes harder, until at last it is impenetrable by water and resists the attacks of insects. The fiber of its wood may be woven into very durable matting, etc.

The tree grows best and bears best fruit south of the Yangtse Kiang River in the provinces of Kingsi, Tschekian, Hunan, Hupeh and Szetschwan, where it is grown for oil production, and where it will grow even in a ground of sand and gravel, while to the north of this territory it is simply grown as a shade tree, because in that climate it will bear but little fruit and above the thirty-fourth degree northern latitude it will not grow at all.

The fruit of the tung tree is a nut, that, as before stated, has the form of a bottle, the inner shell of which is similar to that of a walnut, containing from 3 to 5 kernels, each of which is about the size of a large hazel-nut. The outer shells of the fruit from the trees of the Aleurites cordota are shriveled in appearance, those of the Aleurites Fordii quite smooth. The tung tree does not require nursing, the greatest height attained by it is from 22 to 25 feet, and from the fourth year on, it will bear from 20 to 50 pounds of nuts annually for about ten or twelve years, when it ceases to be productive.

China wood oil, or tung oil, is often confounded with Bankul oil, which is produced from the nuts of the trees belonging to the botanical group Aleurites triloba, that grow on the South Sea Isles, the islands of the Malay archipelago and Reunion Islands, as well as in the East Indies. The kernels of the nuts from these trees, which grow to a height of from 36 to 45 feet, yield 60 per cent. and over of their weight of oil, which is used as a substitute for linseed oil, especially in printers' colors.

When tung oil was first more generally introduced the technical people became slightly mixed as to its proper name, and Chinese wood oil was the term often used, until it finally crystallized itself into China wood oil in the world of commerce and tung oil among the technical world. Simply to designate it as wood oil is rather confusing, as this term has also been used for Garjun balsam and for wood turpentine and pine oil. At the present time, however, it is safe to say that any one interested in the article will know the meaning of the term China wood oil or, if the shorter name is preferred, tung oil.

Production.

Some twenty years ago and for some time afterward tung oil, as we shall in our further description term this very interesting article, came to us through English and German channels of trade, and it was scarcely ever uniform and a great amount of money was wasted before its properties became more fully known to interested parties.

At that time its production was still in the hands of the Chinese peasants exclusively, who used very crude and primitive methods for pressing the oil and bringing it to market. The method was to roast the nuts in iron pans, so that the shells would burst open and thus free the kernels. The smaller producers would pulverize these in hand mills, while the more progressive Chinaman would have a stationary colander, rotating in a stone trough driven by oxen or other animals similar to our olden time cider mills. The meal was then warmed and the oil pressed on hand presses and in order to clarify it somewhat was boiled with water and filtered through linen. Western enterprise has changed this

system to more modern methods, and we now have hot pressed tung oil, as well as hot pressed linseed oil. Attempts have been made to import the nuts of the tung tree into Europe and the United States, but on account of the weight of the shells, that constitutes one-half of the total, it was nearly entirely given up again. To import the kernels only is risky, because of the rapidity with which they become rancid. Some English and American firms have finally introduced modern machinery for pressing or extracting the oil on Chinese soil, and one American firm has put up barrel factories and storehouses for handling the export on a large scale. But this fact is well known and does not require repetition here.

The nuts consist of about equal weight of shells and kernels, which latter yield, when cold pressed, 40 to 42 per cent., when hot pressed 50 to 53 per cent. and in the extraction process 58 to 60 per cent. by weight of oil. Hefter in his Technology, volume II, page 60, reports as the result of cold pressing in hydraulic process as follows:—Out of 100 parts by weight of nuts—First pressing, 22.36 per cent. oil of straw yellow color; second pressing, 5.56 per cent. oil, darker and more viscid; oil cake, 24.08 per cent., and shells, 48 per cent. An analysis of kernels made by the Jardin Colonial (France) resulted as follows:—Water, 5.14 per cent.; protein, 20.60 per cent.; fat, 52.57 per cent.; extracted matter, free of nitrogen, 14.98 per cent.; fibrous matter, 2.85 per cent.; ash, 3.86 per cent.

An analysis made by the same institution of tung nut shells showed the following composition:—Water, 14.40 per cent.; protein, 2.50 per cent.; fatty substance, .04 per cent.; extracted matter, free of nitrogen, 27.62 per cent.; crude fiber, 50.64 per cent., and ash, 4.80 per cent.

Tung oil has been known to and made use of by the Chinese for centuries in a great many ways. It serves as lubricating oil, as a means to make paper transparent and waterproof. Its use as a wood preservative, especially for boats, has been practiced in China from time immemorial, and the soot produced by slow incineration serves as the basis for Chinese or India ink, while the residuum from this process is made use of in caulking of boats and as a vehicle or binder for paint. A mixture of lime, clay and sand with tung oil will produce an imitation of granite.

Physical Properties.

Raw tung oil of commerce is usually light straw yellow in color and of a disagreeable odor, that is designated by many as similar to smoked hog fat, which is difficult to disguise and cannot be removed, while the oil is in its crude state. When the oil is heated the odor is less penetrant, but the practical man will discover its presence even in varnish, after it has gone through the treatment required to make its use safe. Only when a varnish containing tung oil has become dry and perfectly hard the peculiar odor will have disappeared. Part of the odor will disappear when the oil is heated to 120 deg. F. and a current of dry air passed through it for several hours.

It required an enormous amount of research by chemists and varnish makers before they were safe in using tung oil in appreciable quantities without serious pecuniary losses. It was necessary to ascertain the causes of the disagreeable properties of the oil, foremost of which is the drying matt—or flatting—also the sometimes drying of the surface coated with the raw oil with

a frosted appearance. Next is the tendency to coagulate in boiling at high temperature. Then, again, if the oil freezes and is left in that condition over ten days it becomes insoluble, which is explained by the fact that in freezing it expands to the extent of 10 per cent., becomes porous and permits the taking up of an excess of oxygen. It is in that condition difficult to melt, and on cooling forms a jelly that is insoluble.

While tung oil may be heated to very high degrees of temperature, when it has undergone several refining treatments of which we shall speak later on, yet on account of the uncertain qualities in tung oil, the consumers have found it best to heat it with rosin and thus avoid the risk of great losses. And as the original function of tung oil, when first imported into Europe and the United States, was to enable the varnish-making industry to produce low-priced varnishes that would not scratch or rub up, as they had been in the habit of doing, the practice came in vogue generally to melt rosin, adding a hardening medium, such as a salt of lime or lead manganate, etc., and fuse with tung oil, thinning the fused mass with the usual solvent, thus producing what is termed China wood oil varnish, with which to toughen the cheaper grades of commercial varnishes. This has been a boon to manufacturers and consumers alike, stimulating trade in that commodity. There is this peculiarity in the behavior of tung oil when combined by heat with rosin, that its acid number becomes less the longer it is subjected to heat, while linseed oil, when so treated, gives off free fatty acid and increases its acid number.

For instance, pure tung oil with an acid number of 11.8, when heated to 392 deg. F. with rosin, reduced its

acid number to 10.7, and when heated to 472 deg. F. its acid number was only 7. Southern pine rosin heated to 572 deg. F. showed an acid number of 298. When one part by weight of this rosin and two parts by weight of the tung oil in question were heated to 572 deg. F., the mixture did not give the expected acid number of 104.4, but it only showed a number of 66.36. This can only be explained by the theory that a chemical combination is taking place between the rosin and tung oil, whose nature is not yet determined. It may be that this is due to the polymerization, to which tung oil is subject on long continued heating and which shows itself in its disposition of turning into a jelly. At all events this decrease in acid numbers is important in so far that owing to this very fact, tung oil varnishes are miscible with metallic pigments that are sensitive to acid. That tung oil as it comes to us in commerce cannot as a rule be depended upon for uniformity goes without saying, when, as is well known, the Chinese and other Asiatics are not overscrupulous in the selection of the fruits of the various groups of oil trees. On this account it is always safer not to heat the tung oil to over 392 deg. F., although some authorities claim that pure tung oil will not coagulate below 464 deg. F.

Very characteristic is the property of pure tung oil to coagulate when heated to over 400 deg. F. and to remain in that condition on cooling. Tung oil extracted with carbon bisulphide coagulates at a temperature of 212 deg. F. with a melting point of 95 deg. F.

Many trials have been made to avoid the coagulation of tung oil when subjected to high temperatures, and these have been more or less successful. One of these processes that may be mentioned here is patented and

consists of the addition of zinc dust or similar strongly reducing metal in powdered form to tung oil, while it is being heated in an enameled kettle to a temperature of not over 190 deg. F. When the metal has been stirred in and is well taken up by the oil the heat is increased to about 250 deg. or 272 deg. F., and when the oil has been permitted to cool it is filtered. It is not necessary to add more than 0.2 per cent. of metal, and the tung oil so treated will dry very slowly, but with the subsequent addition of siccatives, it will dry very rapidly, even when only small percentages are given. The advantage of tung oil so treated, however, is that it may be heated to at least 420 deg. F. without risk of coagulation.

When treated tung oil is added to linseed oil, raw or boiled, or to ordinary varnish, it increases their drying properties and the toughness of their films, but when raw tung oil or imperfectly treated tung oil is used in this admixture it may lead to coagulation. In extreme cold weather raw tung oil is liable to separate particles similar to stearine wax and assume a waxlike consistency.

One peculiarity of tung oil as compared with other drying oils is that in drying it does not form a skin, but dries in a solid film, and this is explained by the fact that drying oils uniformly dry from their absorption of oxygen from the air, while tung oil becomes fixed through polymerization.

Meister (see Chem. Revue für die Harz u. Fett Industrie, 1910, pp. 150) has determined that linseed oil in drying takes up all the oxygen it is capable of, so that when the film has dried the maximum of absorption has been reached, while tung oil absorbs only one-third of the full amount of oxygen up to the time of drying and

later on the other two-thirds, so that it may be said that in the case of tung oil there are two periods, one of drying and another of complete hardening after drying. Because of this behavior it may be said to dry dust free, like a varnish and harden subsequently to the touch. The oil cake or residue from the pressing of the meal is rich in protein, but is utterly useless as animal food stuff because to quite an extent poisonous. Many experiments have been made to free the material from its poison, but so far without success. But it is recommended as an excellent fertilizing material on account of its poisonous character, it being believed that its use would destroy certain insects. It is claimed that raw tung oil is also to some extent poisonous and that people with sensitive eyes are liable to have them inflamed in having accidentally some of the oil, even a drop, get into their eye.

Bleaching of Tung Oil.

The best and safest method for clarifying and bleaching of tung oil is to place a certain quantity of the raw oil into a tank or kettle, provided with a steam jacket or steam coil and a mechanical stirring device, heating the oil to 250 deg. F. and adding at least 5 per cent., but not over 10 per cent. of its weight of best fuller's earth (which is an aluminum magnesium hydro-silicate), keeping the temperature at 250 deg. F., while running the stirring device for at least one hour, then running the material through a filter press, which would serve its purpose best if heated.

Chemistry of Tung Oil.

The exact chemical constituents have not as yet been accurately determined, simply because tung oil has

never been found uniform, as will be seen from tables of the results of analyses by various authorities in chemistry. One authority, Cloez, asserts that tung oil is a mixture of 25 per cent. of the glycerides of oleic acid and 75 per cent. of margarolic acid, and says that the latter separates in crystals on adding an alcoholic solution, while the former remains in solution. The combination with lead oxide is only feasible after long heating of the oil, the lead soap melts at 212 degrees Fahrenheit, but the oil is easily saponifiable with an alcoholic solution of caustic soda. Another authority, Wenghoefer, as early as 1882 in his chemistry of hydro carbons, says that margarolic acid melts at 105 degrees Fahrenheit, and is a member of the group $Cn\ H_2N_3$—$CO.OH$ with the empirical formula $C_{17}H_{30}O_2$. This acid forms by a change during the heating of over 392 degrees Fahrenheit and has a melting point of 160 degrees Fahrenheit.

Elaeolic acid may be had from elaeomargaric acid (margarolic acid) as well as from elaeostearic acid, when these are heated to about 350 degrees Fahrenheit under exclusion of air. It also forms, when the oil is extracted with carbon bisulphide and heated to 212 degrees Fahrenheit. The acid melts at 38 to 40 degrees Fahrenheit. As all the three acids may be present in mixture and also as glycerides, it stands to reason that the viscosity of the limpid oils, as well as the melting point of the gelatinized oils may be very different depending upon which of the acids is in preponderance. This would explain why tung oil from various shipments will give varying results in practice and shows how necessary it is to test each shipment.

Testing of Tung Oil.

Adulterations of tung oil with cheaper materials have been determined, grease, fish oil and mineral oil being the adulterants principally used, and before rosin oil rose to its present height in price it also was quite a favorite for the purpose. To determine the purity of the oil it is necessary to find the specific weight, the saponification number, the iodine value and the Hebner number also. Here is a table of oils and fats:—

AVERAGES.

Kind of oil.	Specific gravity at 59° F.	Saponification Number.	Iodine value — Oil.	Iodine value — Fatty acid.	Hebner number.	Special characteristics.
Tung oil.......	.936	193	162	165	96.3	Contains elaeomargaric acid; gelatinizes on heating.
Linseed oil.....	.934	186	182	180	95.5	Gelatinizes at 32° F. in the Hexabromide test.
Soya bean oil..	.926	191	124		95.5	....
Nsa-sana oil...	.933	192	148	...	...	....
Bankul oil.....	.923	...	...	...	...	....
Whale oil......	.923	202	124	131	93.5	Odor of train oil; strong discoloration in treating with alcohol, lye or phosphoric acid or chlorine.
Menhaden oil..	.925	190	132	...	96.3	

Nsa Sana oil is closest to tung oil in its general behavior.

In the following table will be found the results obtained in the determination of chemical and physical constants of tung oil by the most noted authorities on the subject:—

Observed by	Specific gravity at 59° F.	Saponification value.	Iodine number.	Hebner number.	Remarks.
De Negri and Surbate	.936	172	161	...	Oil made in laboratory from tung tree nuts;
		155.6	159	...	commercial product.
Jenkins.............	.9385	194	165.7	96.4	
	.9343	192	159.7	96	
Lewkowitch..........	.9415	...	163.4	...	Average of tung oil.
Nash................	.934	...	...	...	Japanese wood oil.
Williams............	...	194.4	160.5	96.5	Average.
Zucker..............	...	197	163	...	....

To ascertain the presence of other vegetable oils in tung oil a good test is as follows:—A sample of appreciable volume of the oil is saponified with Na O H and the

resulting soap disintegrated with H_2S_4O, the precipitate, well washed and the fatty acid that has been separated is well dried. This must not melt below 97 degrees Fahrenheit, for if it does it may be taken for granted that other oils have been present in the sample. While in many varnishes the presence of tung oil can be readily determined by its characteristic odor, this is not always an infallible guide, because in many well prepared varnishes that contained from 20 to 25 per cent. of tung oil the odor has been absent. Still in most varnishes of moderate selling price, even when, on account of a strong turpentine odor, the presence of tung oil is not at once noticeable, it will reveal itself by its odor on setting up when the turpentine has evaporated.

Empirical Examination.

Tung oil, even when mixed with other vegetable oils, gelatinizes under great heat. The jelly from pure tung oil is insoluble, while adulterated tung oil requires a greater degree of heat and the jelly can be liquefied again with addition of turpentine or benzine and other solvents of this character.

Reaction (by Zucker.) Five c c m tung oil are mixed with 2 c m m each of carbon bisulphide and sulphuric chloride. If the tung oil is pure it will go into a jelly, otherwise it will remain liquid.

Chloroform Iodine Test. One gram of tung oil dissolved in 5 cmm chloroform and then mixed with 5 cmm of a saturated solution of chloroform iodine will gelatinize immediately. When 2 grams of tung oil are used in this mixture, instead of one, the mass will be so firm that it may be pulverized.

Eladin Test (by Ulzer.) Ten grams of tung oil are mixed with 5 grams of nitric acid (42 degrees Be) and one gram mercury and agitated until the mercury is dissolved, then allowed to stand 20 minutes and again agitated or shaken for about a minute. Drying oils become solid under this test in from one to three hours, while non-drying oils remain liquid.

Sulphuric Acid Reaction (by Flatt). One drop of concentrated sulphuric acid on pure tung oil forms at once a dark brown skin, which envelops the acid. This skin becomes black in a very few seconds. This reaction does not take place with raw or bleached linseed oil or other vegetable oils, that might be employed for admixtures with tung oil, but may take place with boiled or bodied linseed oil, but in that case the added drying mediums would be readily detected.

Test for Rosin. A sample of the suspected oil is warmed with 70 per cent. alcohol, when the rosin will go into solution, while tung oil is insoluble.

Test for Rosin Oil. Dissolve a sample of suspected oil in its own volume of acetic acid anhydride and add sulphuric acid. When rosin or rosin oil is present there will be a wine red or violet red discoloration of the mixture. (E. W. Boughon at the Seventh International Congress of Applied Chemistry.)

Test for Mineral Oil. When a few drops of the suspected oil are mixed with an alcoholic solution of KOH (hydrated potash), the solution will be clear if the oil is pure, otherwise if mineral be present it will be turbid.

Physical Examination.

The varnish manufacturer can escape a great deal of annoyance and pecuniary losses if he personally looks after this part of his purchases or has someone whom he can rely on look after this end of the business. It is not sufficient to simply take a sample from the bunghole of a barrel on arrival, but each barrel should be well shaken up before a sample of the oil is taken. This precaution is necessary, because only the clear light colored tung oil is really fit for use in varnish. Dark and ill smelling tung oil is of little use in the manufacture of varnish. The situation has no doubt bettered itself of late years and our Chinese friends may have reformed or the European and American buyers at Chinese ports have compelled them to be more honest in their methods of bringing the oil to market. Certain it is that a great mass of tung oil, that was unfit for use, found its way into our markets. As the oil was always sold by weight it often happened that sand and earth, even water was found in the original packages. To keep out of trouble the consumer, be he varnish or paint manufacturer, must see that tung oil is free of moisture, which he can readily ascertain, for when the oil has been well shaken in the barrel or other container and is then still free from turbidity, it may be taken for granted that it is free from moisture. Moisture is mostly due to the presence of vegetable albumen and when the oil is boiled it will break at very low temperature, much of it going into the so-called foots that are of little value in paint manufacture and of none at all in varnish making. It is a fact generally recognized at the present time in the paint and varnish trade that raw tung oil cannot be employed in either paint or in varnish making, because

of its tendency to dry unevenly in a shriveled film, and its further tendency to dry out flat and opaque in spots. There has been no end of experimenting during the past fifteen or twenty years and to show what has been done along these lines, the progress made and the present status is to be considered and described in the remainder of this chapter.

The Principal Uses of Tung Oil.

The research work in the possible uses for tung oil has not, by any means, been completed, as yet, but we may say that so far the chief object has been to find a substitute for linseed oil in the manufacture of paint and varnish. It may be said, however, that tung oil cannot take the place of linseed oil unreservedly, but should be classed as an auxiliary to it, because tung oil has certain characteristics that are missing in the former, especially toughness of film, and water resisting properties. On the other hand, linseed oil is more tractable and does not require so much care in preparation for use in oil paints for general work.

By the boiling process, moisture and albuminous matter are removed from tung oil and in order to avoid kettles from running over, the boiling should be done over a slow fire at first, until all moisture is driven off, when the temperature is gradually raised to 356 degrees Fahrenheit and held at that point, until a sample of oil taken from the kettle exhibits the proper viscosity. At that stage the kettle is removed from the fire and allowed to cool as rapidly as possible. Drying mediums, such as litharge and manganese salts may be added to increase the drying properties of tung oil, but it is not absolutely necessary, as the oil has great

drying energy. So far it has not been found useful in the manufacture of printing inks and lithographers' varnishes, at least there is no record of any one having been successful in that direction. There is a great difference of opinion in the varnish manufacturing trade as to whether comparatively fresh pressed tung oil or oil that has been stored for a long time, produces the best results, when used by the varnish maker. So much appears to be certain, that when made by the addition of tung oil that has been bodied up much in boiling, varnishes become very tough in long storage.

Tung oil can be heated to a point as high as 420 to 435 degrees Fahrenheit without risk of gelatinizing, provided it has been heated at first to not over 272 degrees Fahrenheit until all possible moisture has been driven off, but it must then be kept at the high temperature for about 3 hours and during that time constantly and uniformly agitated, otherwise it will break and coagulate. Tung oil thus treated is claimed to be excellent for use in the manufacture of varnishes from rosin, imparting to them great toughness and resistance to atmospheric influences, almost equal to varnishes, made from fossil gums and linseed oil. When tung oil breaks in boiling without gelatinizing we have tung oil foots, same as we have linseed oil foots, when linseed oil breaks during the boiling process. Attempts have been made to make use of tung oil foots in the manufacture of substitute for rubber and patents have been granted to protect such inventions or processes. In one of these the specifications are as follows:—"Process for making use of the rubber-like mass that is the result of heating tung oil at a temperature of over 392 degrees Fahrenheit for any length of time, consisting in melting the mass

with poppyseed or nut oil at a temperature of 572 degrees Fahrenheit until it becomes soluble in such solvents as spirits of turpentine, benzine, benzol, acetone, amylacetate, etc., and miscible with drying oils, varnishes or pyroxylin solutions." The inventor melts the partly gelatinized portions of tung oil foots in about equal portions by weight with either of the oils described in the specifications, the best policy, however, for the consumer of tung oil to pursue is to avoid by all possible means the breaking as well as the gelatinizing risk and it is recommended wherever it is practicable for the varnish maker to use tung oil in its pure state without admixture with other oils. Furthermore, it should be avoided to add to varnishes that are made with tung oil as much driers as would be given to a varnish of similar nature when made with linseed oil, because it would set too quickly and be soft underneath, thus having a tendency to become tacky. It is also best to use manganese or cobalt resinates rather than lead resinates.

Tung Oil in Enamel Varnishes. Of especial value has this oil proven in the manufacture of varnish for moderate priced enamel paints, where high luster, great hardness, drying properties and wear are features that before the advent and exploitation of tung oil could be had only by the use of selected, high priced, pale, hard gums, that are now so high in cost as to be prohibitive in the manufacture of enamel paint. Of course, it depends on careful manipulation and the selection of the pigments, whether the paint maker meets with success.

Tung Oil in Floor Varnishes and Floor Paints.

The Chemical Revue d. Harz and Fettind, 12 p. 244, contains a formula for colored floor varnish as follows:—

Raw tung oil is heated for 2 hours at 340 degrees Fahrenheit, then permitted to cool and set aside, when after 2 days the clear oil is drawn off from the sediment and heated to 356 degrees Fahrenheit. After one hour it is allowed to cool down to about 265 degrees Fahrenheit, when 2 per cent. litharge is added in powdered form and a small portion of turpentine. When cold, the coloring matter is added." This is merely repeated here as an illustration of how differently experimenters are trying to work out problems. While this formula appears to be very good for clarifying the tung oil for further manipulation in varnish manufacture, the practical varnish maker will not be able to see how this process has produced a floor varnish or even a safe drying oil for a floor paint. The practical varnish maker will still make his floor varnish by fusing his gum with oil and he knows how much tung oil is required to produce the required toughness and hardness, while the paint maker in making floor paints will select whatever varnish best suits his purpose, if he uses any varnish at all along with drying oils and driers.

Rubbing Varnishes with Tung Oil. By omitting part of the linseed oil in the usual formula and substituting therefor a similar quantity of treated tung oil, the varnish maker gained quite an advantage in the manufacture of rubbing varnishes. In the first place the drying was more rapid, the varnishes became clear in a shorter time, they were more easily rubbed to a dead surface and the rubbed surface remained matt, because the occasional sweating had been overcome.

Polishing Varnishes with Tung Oil have from time to time given cause for complaint and the writer knows of more than one instance where table tops and piano tops

had been rubbed and polished in the most approved manner, having a stunning appearance when finished, but in a short time a large space in the middle of the table or piano top showed a dead flat surface that could not be explained away by blaming moist atmosphere or improper ventilation, etc. The trouble was with the varnish which contained a moderate portion of treated tung oil. The conclusion arrived at after a thorough investigation was that the finishers did not thoroughly understand the nature of the polishing varnish and were led astray by the rapid setting, taking "dust free" drying for hard drying, which is very apt to occur in the use of tung oil varnishes. The drying of tung oil in comparison with linseed oil shows a remarkable difference and this seems to explain to a large degree the difficulty spoken of in reference to the polishing varnish. When raw tung oil is applied to any surface, such as glass, for instance, it forms a skin inside of 24 to 36 hours that has a greasy feel, is soft and non-elastic, and only becomes really hard after 6 or 7 days. Raw linseed oil, on the contrary does not form a skin until after the fifth or sixth day, but after that rapidly hardens and is solid or firm inside of 8 or 9 days. Authorities assert that when linseed oil has formed a hard film it does not gain further in weight through absorption of oxygen, while tung oil gains 10 per cent. in weight after it has formed a skin. This could be explained only by the different chemical combination that has been determined in tung oil in comparison with all other drying oils. While linseed oil consists chiefly of linoleic acid, and oxidizes on drying by absorbing oxygen into linoxyn, tung oil on the other hand consists of elaeomargarin, which polymerizes into elaeostearine. This latter body is firm, greasy and non-elastic, which would account for

the forming of the peculiar skin when tung oil is applied in a thin film on glass. Only through the oxidation of the elaeostearine, when a disintegration through the separation of volatile, organic substances takes place, is the process of drying complete and at this time the tung oil film attains the elasticity of linoxyn. The idea that tung oil dries more rapidly than linseed oil is only conditionally correct, but when a line is drawn between "dust free" and "thoroughly dry" there is very little, if any difference. Taking it all in all there is yet a wide field in the uses to which tung oil may be put and the research is by no means completed. There are drying mediums on the market under the name "tungate" that come in liquid form and dry linseed oil within a very few hours, according to percentage added, but the limit is 10 per cent., to exceed which the drier has no further oxidizing action on drying oils, although unlike other siccatives or driers such excess will not seriously interfere with the wearing quality of oil paint. Further uses for tung oil have been found in the manufacture of shellac substitutes for wood polishes, also in producing artificial caoutchouc, and to a great extent it is being employed in the manufacture of varnish for floor oil cloth. The Chinese put two qualities of tung oil on the market, the white and the black oil, the white oil is exported while the black oil, which resembles pine tar in color, is consumed at home for stopping seams in boats. The export value of tung oil from Wuchow and Hankow in the year 1906 was $3,271,000. while in the years 1907, 1908 and 1909 it averaged only $2,100,000 and in 1910 it reached $4,153,000, and while figures for 1911 are not available, it is safe to say that there has been a large increase over 1910.

In conclusion it may be said that tung oil or varnishes, in which it is one of the principal constituents, may be used without risk with all inert or chemically inactive pigments, but it is unsafe for use in connection with lead or pigments containing a lead base, because of its strong tendency to over-oxidation or as painters put it, the tendency to "pudding up." Zinc oxide, when ground in linseed oil, raw or bleached, is also apt, when thinned with tung oil varnish to swell or thicken to a great extent, so much so that the resulting paint cannot be spread and when further reduced to proper consistence the covering capacity is missing. A tung oil varnish, well made with the proper resins and without lead driers, is an excellent material for use with lithopone white, as has been proven by the success of interior flat wall finishes that have been only really successful since the advent of the grinding liquids or mediums that owe their characteristics to tung oil, while the finishes themselves owe their dead flat appearance and moderate cost to the heavy petroleum spirits, with which they are thinned for spreading. The progress made in these materials within a comparatively short time is wonderful.

CHAPTER XV.

PAINT OILS OTHER THAN LINSEED.

There are quite a number of these, drying, semi-drying and non-drying, and not a few have their special uses in paint. The most important of the drying variety is China wood oil or tung oil, which has been fully described as to its origin, characteristics and uses in Chapter XIV and requires no further reference here.

Drying Oils for Colors and Paints.

Poppyseed Oil is, next to linseed oil, most prominent for grinding the finer grades of zinc white and artists' colors, and must be classed among the drying paint oils for the reason that when pressed from ripe seed it dries very nearly as rapidly as raw linseed oil. The reason for the use of poppyseed oil in colors or paints is due to the non-darkening of this oil and its free spreading. Its advantages over linseed oil, however, are overestimated by some paint makers.

Bombay Nut Oil was at one time largely offered at a price somewhat lower than poppyseed oil, was very clear, almost water white, and while the specific gravity of poppyseed oil hovered about .926 this walnut oil was slightly heavier, averaging .932, and its drying property fully equal to that of bleached linseed oil. However, this oil has not been heard from in the market for some time.

Sunflower Seed Oil is also classed among the drying oils, but it has not found its way into general commerce

and therefore nothing more is known about it than has been ascertained in an experimental way, which is that it has the specific gravity of poppyseed oil and nearly all of its other characteristics.

Hempseed Oil also belongs to the class of vegetable drying oils, but this seed being raised principally in Russia and a few other localities in Europe, it is used mostly there as a paint oil; and if any is brought to this country it comes as an admixture with linseed oil. Its specific gravity runs a little below that of linseed oil—between .926 and .930; its drying quality is slightly deficient as against that of raw linseed oil, but the chief objection to its use is its darkening tendency, which makes it serviceable only in outside paint in the darker colors. Russian authorities, however, claim that for wearing property it is far superior to linseed oil. This may be due to climatic conditions.

Other Drying Vegetable Oils, as nigerseed oil, tobacco seed oil, Scotch firseed oil, etc., that are not readily obtainable in commerce, are not at all interesting to the paint maker and color grinder.

Another vegetable drying oil that has been largely imported for some time into this country and Europe, under the name of *Candle Nut Oil*, by soapmakers and is known to science as *Kukui Oil*, is now being tested by progressive varnish and paint manufacturers. It bids fair to be a strong competitor of linseed oil when its characteristics become better known to the trade and it is prepared in a more scientific manner than it is now. When expressed from the kernels it has a rather dark color of reddish character, but when extracted it is light yellow in color and the odor is not so strong as in the expressed article. In the issue of the Oil, Paint and

Drug Reporter of July 14, 1913, Volume 84, No. 2, page 34, will be found a very interesting article on the "*Chemistry of Kukui Oil*," by Alice R. Thompson, where the values of this oil are given as follows:—Specific gravity, .92 at 15.5 Centigrade; saponification value, 179.1; iodine number 155.5; Hebner value, 89.9; soluble acids, 1.71; Reichert Meicel number, 2.86. This would indicate that this oil is so far not quite as good a drying oil as linseed, but considerably better in drying than soya bean oil. It is just possible, however, that by more rational treatment its quality in that respect may be much improved.

E. V. Wilcox, special agent in charge of the United States Agricultural Experiment Station at Honolulu, in a letter dated August 2, 1913, says:—

"While Mr. W. M. Hoogs, of the Algaroba Feed Co., and two or three other parties, are preparing to extract kukui oil, it is not yet on the market as a commercial product. I believe, however, that it will be placed on the market during the present year. I have received numerous requests for the oil in large quantities.

"We find that about 80 per cent. of the oil is readily recoverable by pressure, and that the nuts can be gathered and transported to town from the neighboring forests for about $10.00 per ton. Since the press cake is so valuable as a fertilizer I estimate that the nuts have a total value of $30.00 per ton ($20 for oil and $10 for fertilizer)."

Another drying oil of animal origin is the fish oil known as *Menhaden Oil.* This is barred out, however, from use in many paint materials, especially in interior paints, because of its offensive odor, and is made use of

only in special outside paints, as in roof paints, some stack paints and by some manufacturers in other specialties.

Semi-Drying and Non-Drying Oils.

Among those that interest paint manufacturers mostly should be classed soya bean oil, corn oil, cottonseed oil, castor oil, rosin oil, pine oil, tar oil, seal oil and mineral (or paraffine) paint oil.

Soya Bean Oil averages in specific gravity .926 and whereas raw linseed oil dries to a firm film in six days bean oil requires fully ten days and then the film will not be as firm. When linseed oil was extraordinarily high priced several years since there was quite a great demand for bean oil, and it was quite a task for paint makers to discover methods to make their products dry in the ordinary way. The usual practice was to use equal portions of soya bean oil and boiled linseed oil, or when this would not work out well in some paints the bean oil portion was increased and also the driers. While paints made on such formulas could not pass chemical inspection when linseed oil was specified, and therefore could not contain admixture of bean oil, observations have proved that such paints did wear very well, while paints doped with so-called paint oils or other nostrums went to pieces.

Corn or Maize Oil has been in use in paints for many years, but is made use of only when linseed oil is much higher in price. This oil has very little, if any, drying properties, and will harden to a brittle, rather mealy film in from twenty to thirty days. When used alone for grinding pigments the paste comes from the mill like a cornmeal mush, and emits a similar odor, especially

when the mill becomes heated, as it usually will, the oil not being a good lubricant. It is now chiefly used in putty making, mixed with paint and putty oil in varying proportions.

Cottonseed Oil has no drying properties, but is a good lubricant, and previous to its rise in price, when it came to be used as a cooking and table oil, it was used to adulterate linseed oil. Under certain conditions, such as to keep paint or putty from hardening on long standing, it is still added in small percentages. There can be no mistake about the oil. It is of the same lardlike odor as cottolene.

Castor Oil (a semi-drying oil) in color or paint is used only with pigments that are afterward thinned with guncotton lacquers to produce an elastic yet firm film for metal packages and other special purposes too numerous to mention.

Rosin Oils are not only used in printing-ink making, but were largely employed in making paint for rough surfaces, though since their price has advanced to twice, even three times their former cost, they have been replaced by mineral paint oils to a great extent in paint. Rosin oils are practically non-drying, and while they harden in time will soften again under the influence of sun heat and make the paint film part, or alligator.

Pine Oil and Tar Oil are products from the distillation of wood spirit and of rosin, and are used in the manufacture of marine paints, especially paints for ships' bottoms. These oils are semi-drying and water resisting to a degree.

Seal Oil, the bleached or white variety, is also semi-drying, and on account of its lubricating character is

used by the makers of enamels in small percentage, two in one hundred by volume for free flowing under the brush.

Mineral Paint or Paint and Putty Oil, so called among the trade, is refined petroleum or neutral oil, so named because debloomed. These oils cannot be used without being mixed in certain percentages with boiled linseed oil, as they lack binder and are apt to wash off the surface in case of driving rains. Even when used in large portions in a liquid paint for rough surfaces such paints have been known to wash off when they were supposed to have dried hard a month or two before. Petroleum products of this class will sweat, causing softening of the film and consequent damage by water.

Cheap paint for rough lumber or other rough surface can be made by grinding the base in linseed oil (usually boiled) thinning with a mixture of thirty-five gallons gloss oil (rosin and benzine mixture), ten gallons raw linseed oil and five gallons liquid dryer. Or if it must be still cheaper make a thinner of thirty gallons gloss oil, fifteen gallons debloomed neutral paraffine oil and five gallons lead and manganese drier. In any case, however, grind the pigment to be used as the base for the paint in linseed oil.

CHAPTER XVI.

PAINT THINNERS AND SOLVENTS.

Turpentine, the common name for oil or spirits of turpentine, is obtainable in two varieties, one that is distilled from the sap of the pine tree and now known as gum spirits, the other obtained from the destructive distillation of pine wood, stumps, branches, twigs and knots. The latter is known as wood turpentine and is readily recognized by its extremely penetrating and sometimes tarry odor. It is being used to a limited extent in paint and varnish making, but when so used it is liable to cause trouble with exacting consumers, who do much interior work. Some of these wood turpentines are well distilled and their odor not so very strong, but it really does not pay to handle the goods when gum spirits are moderate in price, the difference being too small. Varnish makers on the other hand use the wood spirits to disguise the benzine odors and on account of the strength do not require as large a proportion as they would require of the gum spirits. However the color grinder should keep clear of the use of wood turpentine especially in connection with coach colors and paints for interior decoration. Before the advent of the many substitute turpentines now on the market, spirits of turpentine were often found to be sophisticated by an addition of anywhere from 20 to 40 per cent. kerosene or heavy benzine and yet it should have been a simple matter for some of the paint and varnish firms, that were thus roped in to detect the adulteration. The specific gravity test alone amounts to nothing,

because with the heavy benzines this can be readily corrected. But the aniline oil test, next to a regular laboratory examination is the safest quick test to detect adulteration with petroleum. This is based on the fact, that aniline oil (oil of sodium) will not mix with any petroleum or its distillates, but will mix with pure gum or wood spirits of turpentine. The test is exceedingly simple: In an ordinary testing tube 6 x 5/8" pour the suspected turpentine to the depth of about one inch, then pour on top of this aniline oil until two inches are reached. Close tube with a cork and shake it violently for ten seconds or until the mixture is uniform, then set aside in vertical position, removing the cork, and observe the result. If after 5 minutes the liquid is not still uniform in color, but shows two stratums, then the turpentine, be it gum or wood spirits is mixed with a petroleum distillate. Another quick test for purity is to place a drop of turpentine on a piece of white paper. It should evaporate and leave no greasy mark in from 5 to 7 minutes. Specific gravity of pure spirits of turpentine should be .864 to .868 at 60° F.

Rosin Spirit is the first run in the distillation process of rosin oil from rosin and may be used as a solvent. It resembles turpentine in general, but may be recognized by a tarry odor and slow evaporation.

Crude Turpentine or as it is sometimes called gum thus or gallipot is the sap or exudation from the long leaf pine and gum spirits and rosin are produced from it. It is sometimes used in marine specialties, but is not a really good material for the purpose.

Venice Turpentine, an oleo rosin from the European larch tree is by far the best for the purpose named above

although 5 to 6 times higher for cost. But it does not fluoresce or turn white, as does crude turpentine.

Petroleum Distillates or *Spirits* are products from the distillation of the crude or mineral oils. The first or lightest gravity products coming over in the process are what we know as gasolines, and these were graded, according to their volatility, 72°—76° and 84° gasooline. But there is good reasons for the belief, that in the present day demand for fuel for automobiles, motor trucks, motor cycles, etc., as well as for gasoline engines, the oil refiners furnish one grade only, as do many of the dealers on the roadsides, who do not hesitate to sell ordinary benzine for gasoline and kerosene for benzine. While gasoline would act as a solvent, the paint maker will not care to employ it, but will adhere to the use of benzine of the 62° type or the heavier benzines of the 49° and 56° variety, which latter serve as a substitute for turpentine.

Kerosene or illuminating oil is of use only in a very few specialties in the paint line, such probably as shingle stains and seam cements for ships or in such other materials, that must keep from drying hard for quite a time. The further products from the distillation of crude oil are simply the paraffine oils, that are further treated and clarified and which then become useful as paint and putty oils.

Other Hydrocarbons or *Solvents* are derived from the coal tar group and are known as solvent or coal tar naphtha, also as coal tar benzol, but are all related to one another, being simply distillates of tar. Can be had in water white form, but also in rather crude appearance.

The crude light oil or coal tar naphtha is of brown color used for thinning liquid tar for better spreading, as benzine will not mix well with tar. It can also be had in the water white form at advanced cost and is then useful in replacing turpentine in stains. By further treatment it serves as the base for the 90% coal tar benzol, which is very much employed in the lightning paint and varnish removers, as well as for burning in certain lamps. Solvent naphtha or coal tar benzol 160° is a trifle heavier in gravity than turpentine and has lately been recommended to be used to a limited extent in certain wood stains, especially for birch wood, cedar, cypress and sycamore. Wood alcohol and denatured spirit of wine are now so well known, that special mention would be out of place.

CHAPTER XVII.

VARNISHES, DRIERS AND JAPANS.

It is not proposed to furnish in this chapter any formulas for the varnishes, driers and japans used by the paint maker or color grinder, but in order to make this work complete, a description of these materials, as they should be, is absolutely necessary. In the first place, a moderate priced *Gloss Oil* or *Rosin and Benzine Liquid* is one of the materials required in the manufacture of barrel paints and cheap liquid filler, as well as for the mixing of a paint oil for barn and roof paints. This so-called gloss oil can be made in a power mixer in the cold way by beating up 450 lbs. rosin of medium grade, say F. or G. with 50 gallons 62° benzine, which will yield about 100 gallons liquid. Or if a kettle is handy with a fire place, the rosin may be melted, and while the rosin is still liquid, it may be removed to a safe distance and gradually thinned down with benzine. The heat process produces the best material. Next is required for the manufacture of varnish stain a good mixing varnish of medium color, that will dry to the touch, when mixed with a minimum percentage of oil color, within 8 or at most 10 hours and can be rubbed with the tip of the finger after 48 hours without dusting. A varnish made from hardened rosin, oil and substitute turpentine with addition of China wood oil will fill the bill here and should be moderate in price. Another good mixing varnish for the manufacture of carriage or so-called buggy paints, porch chair enamels, etc., also good white damar varnish and white enamel mixing

varnish for white enamels, rubbing varnish for use in coach color grinding, as well as a cheap rubbing varnish for use in machinery paints and fillers is enough of an assortment in the line of varnishes for a moderate sized paint factory. With the present day competition the line of raw materials required, multiplies rapidly enough unless the manager keeps his weather eye open and pays attention to the blending.

Driers constitute quite an important part of the material in stock in a paint factory and while the assortment need not be manifold, attention must be given to the requirements. A pale liquid drier, that does not tend to discolor white or light tints to any extent or make them dry out a decided pink, as is the case with driers in which excessive manganese compounds have been used. But in order to make a small assortment of driers answer, this drier should be well concentrated, so that it can be used in different ways. Next would be a liquid drier, that should contain some hard gum, but may be rather dark in color, for use in machinery paints, etc. Sometimes a manufacturer is called upon to furnish paints to specifications, and it is well to have recourse to two kinds of driers, one a straight oil and solvent proposition without gum, the other an oil, hard gum and solvent proposition, the solvent portion being selected as per specifications.

Grinding Japans, sometimes called coach japan, are a feature of a color grinder's outfit, that requires extra close watching. There are two distinct methods of making these, both kinds having the same oil and drying mediums, litharge and manganese, but one is a hard gum, the other a shellac proposition. The shellac japan, is the one most profitable to the varnish maker,

because it does not require long settling, as it is clear and ready for use in less than a week, while the hard gum japan, when made with kauri dust or nubs will require from 4 to 6 weeks to settle clear enough for use. Gold size japan for grinding delicate coach colors is another necessary material for a color grinding establishment.

Liquid driers are best tested for efficiency by mixing 5 parts of it with 95 parts of oil, all by weight, beating the mixture thoroughly, then spread it on a piece of dry glass in thin film and watch it set dust free and also when free of tack. Should set in 12 hours dust free and be hard in 24 hours at the longest. The film must not dry out in wrinkles or tend to creeping or crawling. Varnishes may be applied to glass and body and time of drying noted. Observe appearance of surface, when dry. Apply to bright tin one coat and expose to strong sunlight. A few weeks will give an indication of their wearing properties. Color grinder's japan must dry inside of 30 minutes, when placed in a film on glass and must not show crinkles.

PART IV.

LIQUID PAINTS READY FOR USE.

INTRODUCTION.

Under the caption of grinding bases for ready-mixed paints we have pointed out how this is usually accomplished and that there are several ways of doing this, the most frequent method being to grind the various dry pigments together in oil by established formulas to the consistency of a soft paste, this to be run into or conveyed, as the case may be, to a suitable liquid paint mixer, where additional oil and the drier and volatile thinners or varnish, as called for by formula, are added until the paint has attained standard fluidity and weight per gallon. Here also the tinting colors as required to produce the standard color or shade are introduced, and these, also, should be made rather thin and strained through a wire sieve to keep out lumps or paint skins, because such are very annoying and apt to mislead in the manipulation. But, as stated at that time, it is not essential to the thorough mixing of the paint that the dry pigments be ground together for the base, so long as the various ingredients, that have been previously ground singly in oil, are placed in a liquid paint mixer and beaten up thoroughly before adding the various liquids. So, for instance, white lead in oil, zinc white in oil or these and any extender in oil can be placed in the mixer in certain proportions, so that, when paint is to be made to certain specifications, it is not necessary to make a special grinding to meet requirements, which might at times be rather unhandy and cumbersome.

CHAPTER XVIII.

BUILDING PAINTS.

Before proceeding with this subject it might be well to have a better understanding of the present methods in formulating compositions for ready-for-use liquid paints or ready-mixed paints, that are termed patent paints by some of the old-line house painters. Some of the original manufacturers of liquid paints forty years ago were in the habit of placing two or three brands upon the market. Only one of these, as a rule, showed their name and address upon the label, while the lower-priced brands were given a fancy name, and often a fictitious address, or they bore the address of the jobber or dealer, handling the goods. The higher grade paints bearing the brand, trade-mark and full name of the makers, up to some six or seven years ago, with but few exceptions, consisted of varying portions of pure white lead (basic lead carbonate) and best American zinc oxide (sometimes even French process zinc oxide) in their pigment portions, containing no extending material, but in place of this, were emulsified with a view of keeping the pigment in suspension, at the same time making it possible to compete in selling price with such brands as had a moderate percentage of extender, such as china clay, magnesium silicate, carbonate of lime, or even barytes, in their make-up. Certain brands of the pure lead and zinc paints were originally based on 20 per cent. by weight of dry white lead to 80 per cent. zinc oxide, but gradually, because of the demand for better hiding power, these proportions changed, until

finally, within the last decade, the figures were either equal proportions or 60 per cent. lead to 40 per cent. zinc. Other paint makers, again, from the very beginning, even for their best brand, did not use pure lead and zinc alone, but used extenders to a greater or lesser extent and in addition a few per cent. of emulsion. With the introduction of such extenders as magnesium silicate, clay or gypsum watery emulsions work disastrously if not confined to the very minimum. In a paint that is composed of pure lead and zinc, however, and which is apt to be stored for a year or more, a moderate portion of emulsion is an absolute necessity and not at all harmful to the paint, as has been proven in the case of at least one prominent brand for over thirty years. The uncalled-for legislation on paint labeling enacted by a few Western States some time ago, the wisdom of which we leave to our readers to judge, has produced a research into paint making, which, to our mind, is still unsettled as to actual results in spite of the great number of test fences put up in different sections of the country and the amount of money expended by paint makers' associations and other interested parties, simply because, so far, the test fences have not given any definite idea as to what any special composition of paint will do in the way of repainting old surfaces. The theory that a paint containing three or four pigments of varying texture or structure is better all around than a paint containing only one pigment may be all right so far as hiding power is concerned, but it has yet to be proven that this also applies to wear and durability in repainting over old painted surfaces. The paint maker has no means of knowing the condition of surface where the consumer intends using his paint, therefore the only way left open to him is to produce a

price-worthy article as best he knows how. And, with this in view, we are suggesting the following formulas as the most modern and up to the mark for good wear:—

A. Base for a high-class outside white—

522 pounds dry lead;
261 pounds XX American zinc;
87 pounds magnesium silicate;
130 pounds refined linseed oil;

1,000 pounds soft paste.

This amount of paste base beaten up in mixer with 193 pounds (equal to twenty-five gallons) refined linseed oil, thirty-seven and one-half pounds (equal to five gallons) pale japan drier and twenty-one pounds (equal to three gallons) turpentine will produce a white of good hiding power for exterior woodwork weighing fifteen and one-half pounds per United States gallon of 231 cubic inches, or, in other words, allowing for waste in handling, eighty gallons of outside white ready for use.

B. Base for a lower priced outside white—

260 pounds dry white lead (or sublimed white lead);
260 pounds American zinc, XX;
260 pounds floated barytes;
90 pounds magnesium silicate;
130 pounds raw linseed oil;

1,000 pounds medium soft paste.

Placed in the liquid paint mixer and beaten up with 170 pounds (equal to twenty-two gallons) raw linseed oil and fifty-five pounds (equal to seven and one-half gallons) pale liquid drier will produce a paint that may serve as a second-grade outside white, or as a base for

making tints of the darker type, weighing sixteen pounds per gallon of fairly stout consistency, a batch of seventy-five gallons. By adding to this batch five gallons of the emulsion which will be described below and five gallons more of raw linseed oil the batch will make eighty-five gallons and the weight per gallon will be reduced to fifteen pounds, while the consistency of the paint will be still stout as before.

For light tints base A is to be highly recommended because of its being a clearer white and of its superior covering capacity. For the emulsion referred to figure as follows on a quantity of fifty gallons:—Three pounds borax and three pounds sal soda dissolved in five gallons boiling water; allow to cool, then add two gallons cold water and six pounds silicate of soda 33 degrees Beaume. Stir well and add sufficient water to make up the above quantity. By dissolving two and one-half pounds animal glue in two and one-half gallons of water, the silicate of soda and cold water mixture can be dispensed with. Another emulsion, really better than this and probably the only effective one for liquid mineral paints, is made as follows:—Dissolve in boiling hot water in separate wooden containers the following:—Ten ounces pale glue, twelve ounces borax, twelve ounces sal soda and twenty ounces white sugar of lead. When solution is complete in each case run the solutions into a barrel that is open at one end, the glue solution first, then rinse the container of glue solution with the soda solution and stir this into the glue solution in the barrel. Next run in the borax and finally the sugar of lead solution. Stir well and add enough cold water to make twenty-five gallons. When used with paint containing lead and

zinc no assistant to emulsify is required, but with paint made up of mineral red or brown it is best to add one gallon of rosin varnish (cheap furniture varnish will do) for every two or three gallons of the emulsifier. This will keep the paint well emulsified on long standing when otherwise the mineral pigment will separate from the vehicle and settle and often cake hard in bottom of container.

If a third grade or very cheap quality of liquid paint is desired figure on base B, adding to every 100 pounds of this fifty pounds of whiting in oil (ground at the rate of 75 per cent. whiting and 25 per cent. oil), thinning this mixture with four gallons raw linseed oil, one and one-half gallons liquid drier and one gallon emulsion. This will produce close to fifteen gallons of paint, weighing thirteen and one-half pounds per gallon, and will make a low-priced white base for dark tints.

The three formulas just given for white can be depended upon for good wear on exterior wooden surfaces and if made for locations where sulphur gases are prevalent the dry white lead in formulas A and B should be changed to sublimed white lead (basic lead sulphate).

The use of emulsion should be avoided or it should at least be used very sparingly in paints that contain large portions of yellow ocher, raw umber and raw sienna, also when gypsum constitutes a large part of the base, all the pigments referred to containing large percentages of hycroscopic moisture, and combined water, hence cannot stand much added moisture.

Inside white in gloss finish is not much in demand, the cheaper gloss whites or mill whites made on a base of

lithopone ground in oil and reduced with low-priced pale varnish having taken its place, and the same may be said of interior flat white having been to a large extent replaced or put out of the market by the modern flat wall coatings of which we shall speak later on. As to the inside gloss white, most paint makers put up their outside white under that label, while some made a special white of 33 per cent. white lead and 67 per cent. zinc oxide (French process) ground in refined linseed oil and reduced with a low-priced white varnish of rosin and turps. This paint varied between fourteen and one-quarter and fourteen and one-half pounds per gallon. The inside flat whites were made up from white lead and zinc in the proportions of one third of the former and two-thirds of the latter, also ground in refined oil, thinned with a pale drier, a small portion of varnish and reduced with spirits of turpentine. To insure good flatting a solution of borax was added in small portions. These paints required a weight of fifteen and one-half to sixteen pounds per gallon in order to cover up well.

Solid Colors in Ready for Use Building Paints.

Blind and Shutter Greens or Trimming Greens of the chrome green type are usually mixed from a base containing from 20 to 25 per cent. of chemically pure green, balance of pigment consisting of barytes. The shade may be light, medium or dark, the mixed paint made from the light green being heaviest in weight per gallon, that made from the dark shade being lightest, varying between 14 and 15 pounds. Taking a medium chrome green of the type referred to as the base, the formula will be as follows:—

1,000 pounds chrome green medium in oil (20 to 25 per cent. color);
310 pounds raw linseed oil;
73 pounds japan drier;
35 pounds turpentine;
32 pounds emulsion (25 pounds solution, 7 pounds varnish);

1,450

Result 100 gallons green that will not run or sag on the surface and hold well in suspension. Will show on chemical analysis approximately 59 per cent. pigment and 41 per cent. pigment, and not over 2 per cent. water in the total paint.

Composite Greens for Exterior House Painting can be made from bronze green, bottle green, olive green and moss green in paste form, or may be based on a mixing of pure color, reduced with an extender in oil, as it is commercially out of the question to use strictly pure oil colors for the exterior painting of a house. Take a bronze green, for instance, of dark shade, a formula like this will make a good wearing paint for trimming, etc.:—Twelve pounds lemon chrome yellow paste in oil, 10 pounds chemically pure chrome green paste, dark in oil, 12 pounds carbon black paste in oil or lampblack in oil, 30 pounds barytes ground in oil and 34 pounds fine whiting or asbestine in oil (preferably the latter) thinned with 42 pounds raw linseed oil, 8 pounds japan drier and 4 pounds turpentine will produce 13½ gallons of liquid bronze green of good body and spreading power, weighing 11½ pounds per gallon.

For a bottle green for ordinary outside painting, figure on 30 pounds drop black in oil, 10 pounds chemically

pure chrome green deep in oil, 3 pounds Chinese or Prussian blue in oil, 4 pounds zinc white in oil, and 53 pounds barytes ground in oil, thinned with 35 pounds raw linseed oil, 7½ pounds japan drier and 3½ pounds turpentine, producing 12 gallons liquid paint, weighing 12 pounds per gallon.

Olive greens for exterior woodwork in liquid form can be produced at comparatively low cost on a formula like the following:—

Seventy pounds French yellow ocher in oil, 12 pounds lampblack in oil, 8 pounds white lead in oil, 8 pounds medium chrome yellow in oil, and 2 pounds Venetian red in oil, thinned to brushing consistency with 60 pounds raw linseed oil, 12 pounds japan drier and 4 pounds turpentine, producing 16 gallons paint weighing 11 pounds per gallon. Moss green is made with 45 pounds French yellow ocher in oil, 20 pounds white lead in oil, 10 pounds chrome green in oil, light shade of the 20 per cent. variety, and 25 pounds raw umber in oil, thinned with 35 pounds raw linseed oil, 7½ pounds japan drier and 3½ pounds turpentine, producing 12½ gallons paint, weighing 11¾ pounds per gallon.

Solid Yellows are rarely called for and then usually in the medium shade. Unless the specifications call for a chemically pure yellow, the following makes the best wearing paint:—

Sixty pounds medium chrome yellow in oil and 40 pounds floated barytes in oil, thinned with 38 pounds refined linseed oil, 7½ pounds pale drier and 3½ pounds turpentine. This will produce 11 gallons of paint, weighing 13¼ pounds per gallon.

Solid Red type of liquid paints comprises mostly Tuscan red, Venetian red and bright reds, mostly used for sash and trimming work. For either the Venetian or Tuscan red in liquid form, thin 100 pounds of the paste in oil, with 38 pounds raw linseed oil, 10 pounds japan drier and 4 pounds turpentine, producing 12¾ gallons of a stout liquid paint, weighing 12 pounds to the gallon.

For a brilliant sash red that is often demanded, a paste base in oil, composed of about 15 parts by weight of pure toner of the bluish type and 85 parts of blanc fixe ground in linseed oil, at the rate of 65 per cent. pigment and 35 per cent. oil is of sufficient hiding power. To 100 pounds of this paste figure on 42 pounds of raw linseed oil and 12 pounds japan drier of good strength, to produce 14 gallons liquid paint, weighing 11 pounds per gallon. An addition of Venetian red paste will give better hiding power, but subdue the brilliancy of the reds.

CHAPTER XIX.

FLOOR PAINTS FOR INTERIOR AND PORCHES.

The best wearing floor paints in our experience have been the house paints made from pure lead and zinc bases with pure tinting colors for producing the shade. On interior floors as well as on porch floors these paints when applied rather thin, i. e., reduced with some pure spirits of turpentine and applied in several coats, brushed out to the utmost, have given most excellent service for years, aside from making a very good surface for repainting.

However, there being a large market for lower-priced and fairly quick drying floor paint, most paint makers make special paints for the purpose, the colors usually shown on sample cards being designated as light and dark lead or stone, buff, spruce, drab or dust color, red, brown or walnut and in rare instances, maroon color. Some makers use lead and zinc oxide, some all zinc oxide, some leaded zinc, some sublimed lead and others lithopone as the white base for these paints, grinding bases in paste form and thinning with special thinners with or without emulsion, but most always using more or less varnish of some sort or another. The most recent formulas for floor paints are based on lithopone for the tints where a white base is required and here are a few formulas on that plan, although the paint maker may find it more convenient to use zinc white or lead.

Drab or Dust Color.—Grind 55 pounds lithopone, green seal or its equivalent, 10 pounds whiting, 12

pounds floated silex, 3 pounds yellow ocher, 1 pound Venetian red, 1 pound lampblack in 2½ gallons boiled linseed oil, resulting in 100 pounds paste, which is best thinned to insure hard drying in, say twelve hours, with 4 gallons mixing varnish, 1½ gallons liquid drier and ½ gallon turpentine. This will produce 12 gallons of paint, weighing 12 pounds per gallon. The mixing varnish must be of what is termed a short oil product, drying of itself in eight hours or less.

Lead Colored floor paint may be made on a similar formula by omitting from the base the yellow ocher and the Venetian red, using lampblack only for tinting.

Spruce Color floor paint may be based on a paste of 25 pounds lithopone, 20 pounds yellow ocher, 6 pounds medium chrome yellow, 3 pounds Venetian red, 24 pounds floated silex in 3 gallons boiled linseed oil, thinned as for the drab or dust color.

Red floor paint will require a grinding of 45 pounds Venetian red, 5 pounds zinc oxide, 5 pounds whiting, 20 pounds floated silex in 25 pounds boiled linseed oil. When thinned with 5 gallons mixing varnish and 2 gallons liquid drier the result will be 14 gallons paint weighing close to 11 pounds per gallon.

If Indian red light shade is substituted for Venetian red the paint will pass for maroon color, but only one-half as much Indian red should be figured and the balance of pigment made up with asbestine powder.

Brown or Walnut floor paint is best based on a paste made by mixing and grinding 27 pounds burnt Turkey umber, 3 pounds Venetian red, 5 pounds French yellow

ocher, 5 pounds whiting, 25 pounds floated silex and 35 pounds boiled linseed oil. This paste thinned with 5 gallons mixing varnish, 1½ gallons liquid drier and ½ gallon turpentine will produce 14 gallons paint weighing close to 11 pounds per gallon.

CHAPTER XX.

METAL PRESERVATIVE COATINGS.

This is a wide field and to treat the subject fully would require a volume itself and then not be exhausted as our scientific researchers are discovering new data regarding corrosion of metals as they go along and are advancing new theories as to the paint problem daily. As we cannot wait for them, however, we will have to work on what we know from experience along this line and the author believes that he has not spent almost a life time on this subject without accomplishing some results and establishing some facts.

So much appears to be certain that pure red lead well made and freed from all impurities and containing no vitrified particles will make the best priming coat for iron and steel that is subjected to salt water, provided such red lead has not had an opportunity to over-oxidize the oil with which it has been mixed for application. When pure dry red lead is mixed with pure raw linseed oil within twenty-four hours before application it does not require the admixture with driers or volatile thinners to permit its drying hard, yet elastic on the metal, but will within forty-eight hours become as hard as cement, while if mixed with base material, impure oil, or if permitted to oxidize the oil such red lead paint will not have the preservative qualities that can be had from paints made from other pigments, such as ferric oxide or carbon paints. When these are properly put together from well selected pigments and manipulated with a vehicle that is free from any traces of acidity it

only remains for the metal to be prepared to receive the coating before there is any indication of the formation of rust. Rustless or preservative coatings for iron and steel cannot be made in white or light tints for direct application to iron and steel, as white lead (basic lead carbonate) alone does not inhibit rusting and zinc oxide will not assist it, as it does not withstand expansion and contraction of the metal. Sublimed white lead (basic lead sulphate) and sublimed blue lead are not elastic enough either and therefore the first coat or priming paint for structural iron and steel should be composed of red lead, as outlined above, or an oxide of iron paint of a composition we are about to describe, but must be of necessity a red or other dark color. That such a coating will serve equally well as a second and third coat over a red lead priming and as a primer or first coating in place of red lead to be second or third coated with white paint or light tints has been proven by the author by exposing the paints referred to on iron and steel subjected to sulphur gases and to wind and weather for years. This was before researchers had discovered what pigments had inhibitive properties and what pigments promoted the formation of rust through stimulative characteristics. There is no inclination to belittle the work of scientific research, on the contrary, the author believes that much good will yet come from that source, but life at best is short and we are obliged to work upon the basis of past experience until we have found out more about the effects of certain pigments and vehicles on certain metals and vice versa.

Metal Preservative Black can be made by grinding any good well calcined carbon black in well settled raw linseed oil or fire boiled linseed oil (if the latter is not avail-

able, use the raw oil in preference to the present day boiled oil), using an extender of light gravity and red lead or litharge as drier in excess, thinning with fire boiled linseed oil and hard gum japan and turpentine for a moderately slow drying paint, while for a paint that will be subjected much to contact with sulphur gases, an addition of very hard gum varnish will make the paint more impervious. These hard gum japan and varnish compounds should have been proven by exposure tests extending through several years in order to feel secure, and an excellent paint of this kind in black can be made as follows:—Grind a soft paste by mixing 12 pounds best gas carbon black, 6 pounds powdered litharge (or 3 pounds each litharge and red lead), 24 pounds finest floated silica or silex, 3 pounds whiting in 55 pounds raw linseed oil and thin this soft paste with 10 gallons fire boiled linseed oil and 1 gallon hard gum japan. This will make 20 gallons of paint, weighing a trifle over 9 pounds per gallon. If hard drying and protection against the infiltration of gases is to be a special feature use a portion of hard gum varnish in place of the fire boiled oil for thinning.

Metal Preservative Red may be made by grinding a base of 40 pounds bright red oxide of 95 per cent. purity, 8 pounds red lead, 2 pounds zinc chromate, 25 pounds floated silex or silica in 25 pounds raw linseed oil thinning same with 5 gallons raw linseed oil, 1 gallon hard gum japan and ½ gallon turps. This will produce 12½ gallons of paint weighing a trifle over 11½ pounds per gallon. By substituting a long stock of hard gum varnish for part of the 5 gallons raw oil a hard drying product will be the result.

Metal Preservative Maroon.—By substituting for the bright red oxide deep Indian red in similar quantity, a rich maroon paint of same quality as the red will result.

Metal Preservative Brown.—Thirty pounds burnt Turkey umber, 10 pounds French yellow ocher, 5 pounds Indian red, 20 pounds floated silex, 3 pounds whiting, ground in 32 pounds raw linseed oil, thinned with 5 gallons raw linseed oil, 1 gallon hard gum japan and 1 gallon turpentine, producing 14 gallons of a rich brown paint, weighing 11 pounds per gallon. Same remarks as to substituting hard gum varnish for the oil apply here.

Metal Preservative Green of the bronze green type is best made by grinding a paste base as follows:—Ten pounds bone black, powdered, 15 pounds medium chrome yellow, 3 pounds Chinese blue, well oxidized, 5 pounds litharge, 5 pounds zinc oxide, 30 pounds floated silex or silica, 32 pounds raw linseed oil, thinning with 5½ gallons raw linseed oil, 1 gallon hard gum japan and 1 gallon turpentine, producing 14½ gallons rich green paint, weighing about 10¾ pounds per gallon. Same final remarks as to the varnish substitution.

A few remarks in connection with metal preservative paints will not be amiss. A paint for metal must necessarily lay down closer to the surface than is the case on wood, where the pores absorb excessive oil, while on iron and particularly on steel the excess in oil must necessarily harden by absorbing oxygen from the air. Hence it is necessary for the paint maker and seller to do all he can towards educating consumers to handle paints on metal more carefully than those for wood and in labeling these paints, cautions should be embodied in the directions on the packages. By doing so the paint maker may save himself a vast deal of annoyance.

CHAPTER XXI.

CONCRETE AND CEMENT COATINGS.

This line of paint making is coming to the fore rapidly and there are, even now, many brands on the market that are offered for the purpose of coating such surfaces to keep them from dusting or withering and to make them pleasing to the eye as well by color schemes when it comes to walls, interior and exterior as well. A most important feature, however, is the coating of cement floors, concrete reservoirs, silos, cisterns, etc. Here is the most difficult problem for the paint maker, and very few of the brands offered for the purpose so far have given satisfactory results. Up to within a few years ago various preparatory treatments for concrete and cement surfaces have been suggested to be applied in advance of painting, but while at least one of these gave satisfactory results in holding back alkalinic action of cement, even this was finally frowned upon by consumers as being a waste of time and labor, and the demand was for paint coatings of a nature that made the application of chemical solutions unnecessary. Carbonate of ammonia in solution was one method suggested for treating new cement walls, while a saturated solution of zinc sulphate as a wash in several applications was another, and a third was a solution of eight parts oil of vitriol in 92 parts water for roughening the surface and converting the lime in the cement into the harmless sulphate of calcium, to be followed with any good priming paint as used on interior or exterior work generally finished in the usual manner. The sulphuric acid treatment has no

found favor, because it affects the surface of the cement too strongly, and as pointed out above, the other treatments were found too cumbersome. It would be a waste of time to describe the compositions of the patented concrete coatings which appear to cover almost any possible vehicle that would seem to go far towards holding back the action of fairly fresh cement. Some of the other brands that have been selling fairly well show a composition of equal parts zinc oxide and either calcium carbonate in the form of marble dust, or calcium sulphate in the form of gypsum, or lithopone white and zinc oxide with magnesium silicate for pigment with a vehicle of linseed oil, gloss oil, pale drier and heavy naphtha. These, while comparatively low for cost, are not well adapted for waterproofing walls or for use on floors, unless finished eventually with other paints that give the finish desired.

It is an established fact that linoleic acid is a good coating for holding back lime in cement mortar, but in order to make it available in a concrete or cement coating, it is best used in connection with other vehicles. The following formula has been tried with very satisfactory results on various cement plasters, both inside and exposed to the weather:—Ten pounds of builders' lime are slaked with three gallons of water and covered up. After 24 hours the liquid is poured off, filtered through cloth, and set aside. Grind in a suitable mill 60 pounds Green Seal lithopone with 10 pounds raw linseed oil and 12 pounds refined paraffine oil (paint oil). Return this to a change can mixer and add first four pounds of the above lime solution, and then eight pounds linoleic acid and six pounds of pale tungate drier. This produces 100 pounds of a stout paint, weighing 15

pounds per gallon, but is most too stout for easy working on porous surface and should be reduced with one gallon heavy petroleum naphtha, producing seven and two-thirds gallons of paint, weighing 14 pounds per gallon. The lithopone can be replaced by zinc oxide, but in that case it is advisable to use a portion of finest floated barytes, say two-thirds zinc and one-third barytes. For tinting this paint only lime proof colors should be used, and when the proportion of color is small, the colors are best ready ground in linseed oil, otherwise where deep colors are wanted the dry colors are best ground together with the white pigment, increasing the vehicle portion accordingly. Limeproof colors comprise all blacks, ultramarine blue, oxide of chromium green, green earth, yellow and red ochers, red oxides, siennas and umbers, raw and burnt, also zinc chromate. Paint made by the above formula will seal the concrete or cement surface with one application, but, of course, show a dull finish, nor will it dry with high gloss on second coat, but will make an effective priming coat for walls and floors as well.

CHAPTER XXII.

BARN AND ROOF PAINTS.

Barn and *Roof Paints*, so called in distinction from the general line of ready mixed house and building paints to account for the difference in quality and selling price, are made to meet the demand for low prices, and the line of colors is usually confined to red, brown, slate or lead color, moss green or olive green. It is astonishing what nostrums have been sold under that name in the Far West, especially in red and brown. But we will omit a description of these and leave it to the reader's imagination, what this dope must have been when we state that such goods were sold to jobbing houses at from 30 to 35 cents per gallon in one-gallon tins at a time when linseed oil was 60 to 65 cents per gallon. Barn and roof paints are, when so branded, not recommended as the best paint for tin roofs, but more for shingle roofs that are not stained, for fences, outbuildings, etc., while for tin roofs on dwelling houses the best oxide of iron paint is none too good. Such a paint, either in red or brown, should be composed of the following ingredients:—

Red.—Sixty pounds Venetian red, consisting of 30 to 35 per cent. sesquioxide iron, ground in raw linseed oil to medium stiff paste, thinned with 4 gallons (31 pounds) raw linseed oil, 5 pounds liquid drier, 1 pound rosin varnish and 3 pounds emulsion, as described previously. This paint will keep well in suspension in sealed packages and weigh 11½ pounds per gallon, and if the red is well selected and free of soluble salt of iron the paint will preserve the tin for years, provided the underside

of the tin has been well coated before the laying of the roof. The same applies to *Brown Paint* for tin roofs, when it is made as follows:—Fifty-eight pounds of metallic brown, free from the by-products of sulphuric acid plants, ground in pure raw linseed oil to medium stiff paste, thinned with 31 pounds raw linseed oil, 5 pounds liquid drier, 2 pounds rosin varnish and 4 pounds emulsion as above. This will make a paint of good covering capacity weighing 11 pounds per gallon.

Slate or *Lead* color of high quality for tin roofs should be composed of pigments that are not apt to scale readily, hence zinc oxide should be used sparingly or not at all. Pure white lead or sublimed white lead with a good portion of inert mineral base to reduce cost, tinted with pure oil lampblack, will give best results here. For example: 35 pounds white lead in oil, paste, 10 pounds whiting in oil, paste, and 20 pounds asbestine in oil paste, 3 pounds lampblack in oil, paste, 25 pounds raw linseed oil, 5 pounds liquid drier and 2 pounds emulsion will produce 7½ gallons of a slate or lead color of medium depth, weighing a little over 13¼ pounds per gallon. If the paint is to be used at once the emulsion could be omitted, which will increase the weight to 13½ pounds per gallon and decrease the quantity of the batch by one-quarter gallon.

When moss green or olive green for tin roof in the best quality is wanted nothing better can be offered than those greens made by the formulas given for house paints, but if the cost is too high for their use on roofs the paint maker has recourse to the inert bases described under extenders and fillers and their use, as these greens will carry large percentages of inert base before losing their hiding power. Coming back to the lower priced

Barn and *Roof* paints for the purposes indicated above on rough surfaces, we will give a few typical formulas and of course the paint maker can vary these to suit his ideas as to cost of production. For a fairly bright red barn paint he can grind a base as follows:—Fifteen pounds native red oxide (which runs anywhere from 75 to 90 per cent. in sesquioxide of iron), 15 pounds whiting and 45 pounds asbestine powder ground in raw linseed oil or, in case the market in that commodity is too high, in part linseed and part corn oil, requiring 25 pounds of oil to produce 100 pounds of paste of light gravity. Thinning this base with 20 pounds raw linseed oil, 8 pounds gloss oil, 15 pounds paint oil and 8 pounds drier will result in 13¾ gallons of paint, weighing 11 pounds per gallon.

Or the 100 pounds paste may be thinned with four gallons raw linseed oil, one gallon strong drier, one gallon gloss oil and two gallons emulsion, producing 14½ gallons paint, weighing 11 pounds per gallon, this costing, however, a few cents more per gallon, but making a safer paint for woodwork.

A brown barn paint can be made on the same basis with the exception that the paste should be composed of the following ingredients:—Forty-five pounds metallic brown, 10 pounds whiting, 23 pounds asbestine powder, ground with 22 pounds raw linseed oil. The same rule for thinning would apply here and the weight per gallon will not materially differ from that of the red.

A lead colored barn paint can be made without the use of white lead or zinc oxide, and the use of lithopone white is suggested. Twenty-five pounds lithopone, green seal, 10 pounds whiting and 45 pounds asbestine ground in 20 pounds linseed oil, producing 100 pounds

paste with from 2 to 2½ pounds lampblack in oil for tinting will make a dark slate or lead colored paint when thinned with 15½ pounds raw linseed oil, 15 pounds paint oil, 8 pounds gloss oil and 7 pounds strong drier, weighing 13½ pounds per gallon, covering well on woodwork on barns or fences, etc. This paint will not be far in excess over the cost of red or brown and it is necessary to keep within that scope because the trade will not stand any variation in price on this line of paint, no matter what the shade or color may be. Olive green of this type is usually produced in larger establishments from remnants of higher quality brands, extended with inert base, while for the smaller manufacturer the most convenient way is to grind a suitable base on the following plan:—A base made by grinding 25 pounds American yellow ocher of good quality, 8 pounds zinc oxide, 2 pounds chemically pure green, medium, 3 pounds lampblack, 32 pounds asbestine powder in 30 pounds raw linseed oil. Thinning this paste with 23¼ pounds raw linseed oil, 16 pounds gloss oil, 8 pounds japan drier and 8 pounds emulsion will produce 14 gallons paint, weighing 11 pounds per gallon. For a moss green use a similar base, omitting the zinc oxide, but 3 pounds more chrome green increasing the asbestine powder to 37 pounds.

CHAPTER XXIII.

SHINGLE STAINS.

Shingle Stains of High Quality can be produced only by using the strongest and finest oil colors as base, because they are chiefly used for staining the shingles before being laid. Coal tar creosote is introduced as part of the vehicle for preservative quality, wood creosote having been found wanting in that respect. Aside from creosote all manner of thinning materials have been used, from common kerosene oil to petroleum benzine, gasoline and benzol. The latter is beneficial especially for certain woods, but competition in prices will not permit any extensive use of it. For light stains the usual run of creosote is by far too dark and cresylic acid is used instead in spite of its high cost. We will confine the description of the composition of shingle stains to a few formulas for the most popular colors and may mention the fact that stains made by these have held out splendidly for seven years, the roofs looking as good as new, the shingles having been dipped before being laid and afterwards given a brush coat of the stain.

Deep Green Stain (Chrome Green Type).

Fifteen pounds chemically pure chrome green deep in oil, one gallon benzine japan drier, four gallons creosote oil, four gallons heavy benzine. Result, 10 gallons.

Mineral Red Stain (Venetian Red Type.)

Seventeen pounds red oxide (95 per cent.) ground fine in oil, one gallon benzine japan drier, four gallons creosote oil, four gallons heavy benzine. Result, 10 gallons.

Walnut Brown Stain (Dark).

Thirteen pounds burnt Turkey umber, ground in oil, one-half gallon benzine japan drier, one-half gallon 160-degree benzol, five gallons creosote oil, three gallons heavy benzine. Result, 10 gallons.

Silver Grey Stain.

Twenty pounds zinc white, ground in bleached linseed oil, one-eighth pound lampblack in oil, well beaten up with one quart pale liquid drier, after which another quart of same drier is added, also one-half gallon straw colored cresylic acid and when well mixed, eight gallons heavy benzine. Result, 10 gallons.

To decrease cost, when necessary, part of the heavy benzine may be replaced with 110-degree test kerosene, but under no condition should an attempt be made to lessen cost of production by adding base material to the color, as it does not hold in suspension, nor should aniline colors be substituted for pigment colors. Sometimes it is desired to have shingle stains without creosote oil or carbolic acid of any kind, and in that case it is best to replace creosote, carbolic or cresylic acid by using part turpentine with high test kerosene and heavy benzine. Or, for example, to make a rich brown stain without creosote, mix 14 pounds hurnt Italian sienna in oil, break up with one-half gallon japan drier, add one gallon each linseed oil and turpentine, another one-half gallon drier, two gallons high-test kerosene and four gallons heavy benzine to make 10 gallons of stain.

CHAPTER XXIV.

STAINS.

Oil Stains and Varnish Stains with Pigment Bases.

While of late years some paint makers have listed stains with fancy names in these two lines, the most popular are still those that imitate natural wood, as light and dark oak, cherry, mahogany, walnut, rosewood and, perhaps, ebony. When we speak of oil stains we do not refer to a stain made of oil and pigment only, as such a material would not penetrate into the wood fiber. It simply indicates that oil is the binder, while volatile thinners, such as turpentine, benzine, solvent naphtha or benzol furnish the penetrating agent. The colors forming the base should be ground very fine in raw or boiled linseed oil, and the stronger the color in staining power, the more effective the stain and the less color is required. It stands to reason that base material should not enter here, as it is useless and only tends to cloud the effect of the stain. The following formulas for oil stains are based on high-quality goods, where permanency of color is preferred to low first cost:—For 10 gallons of stain use as a base for light oak, five pounds each raw Italian sienna and French yellow ocher, ground in oil. For dark oak, use eight pounds raw Italian sienna, one pound burnt Italian sienna and one pound burnt umber, all ground in oil. For cherry use five pounds each burnt Italian sienna and French yellow ocher in oil. For mahogany, six pounds burnt Italian sienna and four pounds maroon lake or rose pink in oil. For dark walnut use five pounds each burnt Turkey

umber and Vandyke brown in oil; if light walnut is desired, use 10 pounds burnt Turkey umber of reddish tone in oil. For rosewood use 10 pounds rose pink and five pounds burnt Italian sienna in oil. For ebony use Nigrosene B (fat aniline color that has been dissolved in turpentine by gentle heat on a sand or hot water bath), two and one-half pounds color will be sufficient for 10 gallons of stain, if dissolved in one gallon turpentine. To any of the above bases add gradually, while beating up in suitable mixer, three-quarters gallon strong liquid drier, seven gallons boiled linseed oil, and one and one-half gallons turpentine. To reduce the cost of manufacture the quantity of oil may be reduced by one-half and heavy benzine substituted for both the omitted oil and the turpentine, but in that case the liquid drier should be increased to one gallon. The bases given for oil stains will also answer for pigment *Varnish Stains*, using the same quantity as given above for every ten gallons produced. A quick and hard drying varnish is required and the oil colors in each case should be first broken up in part of the liquid drier, of which at least one-half gallon should be used before adding the varnish, of which about nine gallons is required. If the varnish is too heavy in body add some turpentine or benzine, in addition to the drier, to the color before mixing it with the varnish. Make the stain flow freely from the brush and strain the material well before putting it up in the containers. Ebony is not called for in varnish stain lists, but Bog Oak Green is, and to produce 10 gallons of this would suggest the following:—Four pounds chemically pure chrome green medium in oil, one pound burnt Turkey umber in oil, and three pounds French yellow ocher in oil, thinned with one-half gallon strong liquid drier and nine gallons varnish as above.

The varnish should be what is known to the trade as mixing varnish and should not powder, when after drying, it is rubbed with the tips of the fingers.

Interior Decorative Stains:

These stains are not made to imitate any natural wood, but are to give effects to harmonize with the general decorations or hangings in rooms of private residences or offices, etc. They are made to penetrate well into the woodwork, on which they are applied and with a dull effect, from which a luster may be brought out by different treatments, such as waxing, shellacking, varnishing and polishing. The better class of these are based on permanent pigments, similar to the oil and varnish stains just described, but while they are really oil stains, are made to dry more rapidly by using volatile thinners for the most part. They are applied with a brush, and before having had time to set, the surface is wiped with cloth in order to bring out the effect of the grain in the wood, the latter is filled with paste fillers as soon as the stain becomes dry, while close grained woods are treated by applying shellac or liquid filler over the stain or they are waxed, which latter makes the best finish on Southern pine, while shellac is best for soft pine, white-wood or maple. It would carry us too far to give any number of formulas for stains of this type, therefore we will confine ourselves to a few examples. For instance, a nut brown is desired. To produce 10 gallons of stain use 12 pounds drop black in oil, two pounds Venetian red in oil, and one pound medium chrome yellow in oil, one gallon strong japan drier, one gallon mixing varnish and seven gallons turpentine.

Break up the oil color in part of the drier before adding the other ingredients. For a forest green stain use two pounds Chinese blue in oil and 12 pounds Dutch pink in oil, beat up the colors in part of the one gallon strong drier and add mixing varnish and turpentine as above.

Stains with Aniline Colors as the Base.

While the pigment stains are most permanent, aniline stains give clearer and more brilliant tones, and though most of them are prone to fade under exposure to strong light, they hold up fairly well when protected by varnish. The fat aniline colors, oil soluble, are very strong and it does not require a great deal of the color to produce a gallon of stain. The colors may be had in black, brown, blue, green, orange, several shades of red, and yellow. They are furnished in lump as well as in the powder form, the latter being most convenient. One to one and a quarter pounds of the stronger of these colors (red) dissolved in one gallon of turpentine will make the base for 10 gallons of oil stain; in the other colors, excepting brown, a little more color will be required. To the color dissolved in turps add, for oil stain, one gallon strong japan drier, three gallons of boiled linseed oil and five gallons more of turpentine or benzine, as desired.

To make *Aniline Varnish Stains* dissolve the fat aniline colors same as for oil stain in turpentine, using one gallon of the latter and adding nine gallons of mixing varnish of good body. If the latter is slow in drying, cut quantity to eight gallons and use one gallon good strong japan drier.

Aniline Spirit and Water Stains.

These can be readily produced by dissolving spirit or water soluble aniline colors in these liquids, but these preparations are not commercially profitable to the paint maker, as the consumers purchase the powders and do their own mixing.

CHAPTER XXV.

DIPPING PAINTS.

Dipping Paints for Wood or Metal require to be made specially for either surface, as that intended for wood will not always serve the purpose for metal. The paint for wood requires to contain a pigment that acts as a filler, while tin or smooth sheet iron or steel does not necessarily need it, in fact, it is best without it for certain metallic surfaces. The function of a dipping paint is, first of all, to economize in labor, to cover uniformly any article immersed in it, and to dip freely without leaving fringes of paint at the edges and dry equally all over the surface thus coated.

The most difficult problem in preparing a dipping paint for metal is to have the paint adhere to high ridges and sharp corners or edges, and this is most difficult of all when the paint is to dry with a semi-gloss or full gloss finish. Dipping paints for wood are used in sash and door works, where the finished frames, sashes and doors are dipped in liquid primers to keep them from warping through exposure before being set. These are generally cheap goods bought in liquid form and still further reduced by the addition of ordinary benzine or turpentine substitute. The usual method for making these was to grind zinc oxide and whiting in a mixture of linseed oil and gloss oil, thinning the semi-paste thus produced with petroleum naphtha (benzine) until of good consistency for brushing, because the paint is usually wanted in that form. At the present time, how-

ever, the usage is to make a grinding of lithopone and whiting or asbestine powder in raw linseed oil, thinning with gloss oil, drier and benzine, tinting the resulting paint with lampblack in oil a very light gray or lead color. A formula for such a paint that is finding favor is as follows:—Twenty-three pounds lithopone, green seal, 30 pounds bolted whiting and 16 pounds asbestine powder are ground in 15 pounds raw linseed oil and five pounds gloss oil, producing 89 pounds semi-paste, which, after cooling, is reduced to brushing consistency with a mixture of 10 pounds gloss oil and five pounds benzine. The result is 104 pounds of paint, equal to eight gallons. It will not require over four ounces of pure lampblack in oil to make this a very light gray tint. Implement manufacturers use dipping paint for woodwork, such as lawn swings and the parts of farming implements, wagons, etc., and as a rule, where they use the paints mainly to stain and fill the wood and varnish over afterwards also for dipping, they purchase their requirements in paste form, thinning with naphtha, as they can purchase the latter at as low a price as the paint maker. But when it comes to what is called a one-coat dip gloss paint, the paint maker has some show of securing the trade for paint in liquid form. A bright red one-coat gloss dipping paint can be made by grinding para toner with a sufficient quantity of asbestine powder in boiled linseed oil to soft paste form, adding sufficient strong japan drier to make this dry of itself inside of eight or ten hours, reducing this material with a free-flowing mixing varnish of rather thin consistency until the paint drips freely from hard wood, while covering the same uniformly. Or the color and base may be ground in part boiled linseed oil and drier, as in the following formula:—

14 pounds para toner, blueish, pure,
56 pounds asbestine, dry powder,
20 pounds boiled linseed oil,
10 pounds strong drying japan.

Result, 100 pounds paste—7 gallons.

For each gallon of this paste add at least two gallons of a mixing varnish as outlined above.

When a blue one-coat gloss dipping paint is wanted, keep lead out of your base, use zinc oxide instead, or still better, lithopone, with enough good suspending material to give the required filling, and then beware of using a mixing varnish made with Manila gum in any case and China wood oil varnish, when zinc oxide is the pigment base. Dipping paint for sheetings of tin, if in red, give best results when a good red oxide, high in percentage of sesquioxide of iron is selected and ground fine in linseed oil with its own weight of a fine quality of magnesium silicate to a medium paste. Should be thinned, if selling price will permit, with spirits of turpentine, otherwise with substitute turpentine or benzine, adding sufficient good japan in either case. If gloss finish is desired one-half of the solvent thinners should be replaced with a good mixing varnish.

A good formula for a dipping paste that will adhere well to tin on drying and not run or sag during the drying process may be made as follows:—Grind to impalpable fineness 250 pounds red oxide, containing at least 90 per cent. sesquioxide of iron, preferably native red, 250 pounds magnesium silicate (known to the trade as asbestine) in 165 pounds boiled linseed oil. To this soft paste add, mixing thoroughly, 10 gallons best drying

japan and 40 gallons turpentine or heavy naphtha, as desired, or as selling price wll permit. Result 100 gallons.

The same red paste will answer for a high-grade dipping paint for iron, such as railings, fence posts, or the iron parts of implements, if the 665 pounds of paste is thinned with 15 gallons of good liquid drier and 35 gallons hard drying mixing varnish. These, however, are paints which will find favor only with exacting consumers, because of the price it is necessary to charge.

We do not intend to publish formulas for dope mixtures, and if any paint maker should be interested in such, he can readily work them out from the foregoing by simply using lower priced vehicles and thinners. So far as the pigments are concerned, there is very little to be gained by cutting cost in that direction, and it will be found that whenever too much extending base or base material is used in the pigment it will end in complaints on the part of consumers and loss of trade that was in the first place difficult to obtain.

CHAPTER XXVI.

MODERN FLAT WALL FINISHES.

It is a well-known fact to the trade that the evolution of these flat finishes is due to a great extent to the efforts of the manufacturers of lithopone, both here and abroad, to find a greater market for this white pigment than that derived from the linoleum and oilcloth and shade cloth makers. That the efforts have been successful is proven by the favorable reception this material has received and the enormous output since the first brand was placed on the market by a certain varnish house. Quite a share of the credit for its success is due to the availability in late years of China wood oil varnish preparations and the progress made by petroleum refiners in perfecting the heavy gravity petroleum spirits generally known as turpentine substitutes. The ordinary 62 degrees petroleum benzine would not have given the flat finish, and would have made the paint set so rapidly that it could not have been spread, while the addition of more oil would have tended to gloss up. Again, for a certain period the cost price of turpentine almost prohibited its use. Several years ago a number of varnish makers issued formulas for paint makers showing them how to prepare flat wall finishes by using the liquid supplied by them for the purpose. The results obtained by following these formulas varied considerably and even the batches made from time to time did not always turn out uniformly. One of the formulas in question, issued by one of the most prominent firms of varnish makers in the United States with

a branch in Canada, is as follows:—"Paste base to be ground on suitable mill:—

137½ pounds G. S. lithopone (brand specified);
25 pounds XX New Jersey zinc;
18¾ pounds china clay, bolted English;
31¼ pounds bolted whiting;
60½ pounds flatting grinding liquid;

273 pounds.

Blued with 1 ounce dry ultramarine blue. To the above add in a suitable mixer 4 gallons of a mixture of 46 parts by volume of turpentine substitute and 4 parts turpentine, producing a batch of 18 gallons weighing 16½ pounds each." What benefit the 4 parts of turpentine would have with 46 parts heavy petroleum naphtha is difficult to understand. The flat finish made in this formula did not work as well as the following given out by another firm of varnish makers:—"Grind on a water cooled mill these ingredients:—

137½ pounds G. S. lithopone;
25 pounds XX horsehead zinc;
30 pounds bolted English china clay;
20 pounds English cliffstone white, bolted;
1–16 pound dry ultramarine blue;
63½ pounds flatting liquid (8½ gallons);

276 1-16 pounds.

Result:—19 gallons flat paint when thinned with 4½ gallons turpentine substitute or with 2¼ gallons each of this and spirits of turpentine." This paint works fine, dries dead flat without sheen, but cannot be cleaned by scrubbing with water containing any alkaline soap, soap powder or ammonia.

A washable flat wall paint which, however, shows a slight sheen, that has been made and sold for years successfully, is composed of the following:—Grind fine on a good white paint mill:—

360 pounds green seal lithopone (normal);
40 pounds American Paris white (bolted);
5 pounds zinc resinate, powdered;
50 pounds refined or bleached linseed oil;
10 pounds spirits of turpentine;
15 pounds turpentine substitute;

480 pounds paste.

The zinc resinate serves as drying medium and should be ground fine in part of the oil before it is added to the batch, or fused resinate of zinc may be dissolved by heat in the oil and so added. The idea of using zinc resinate instead of manganese resinate is because the latter makes whites dry out rather pink. To every 75 pounds of this paste base use either 10 pounds of turpentine substitute or equal parts of this and pure spirits of turpentine. Result:—Five gallons of flat wall paint of very good body weighing 17 pounds per gallon.

Although some interested parties assert that a good flat wall finish can be produced only by the use of lithopone, it has been demonstrated that such a material can be made by using zinc oxide and inert base. Of course, zinc oxide lacks in opacity in comparison with white lead or lithopone, but under certain conditions it becomes necessary to sacrifice economy to other considerations. Lithopone white is liable to become discolored even on interior walls from the effects of moisture and glaring strong light, while pure zinc oxide, free from sulphur, is unaffected. There has been a

belief in paint making circles that zinc oxide cannot be flatted as can white lead or lithopone, but when it is considered that zinc oxide with the proper white base requires more vehicle for grinding and thinning than lithopone and much more than white lead, it stands to reason that only the right selection of base is required. A very good base for such a flat wall finish will be found by grinding equal parts of American zinc oxide and precipitated barium sulphate (blanc fixe) in a flatting liquid that has given good results with lithopone, thinning the resulting paste base with a good substitute turpentine, and if this should set too quickly for good flowing and drying without laps, add sufficient bleached linseed oil to overcome the deficiency. The blanc fixe may be replaced by equal parts of floated barytes and magnesium silicate, but to increase the percentage of zinc oxide in order to give better opacity would not work out satisfactorily.

Interior Flat Enamels that are found on the market and many of which are imported from abroad are really higher priced flat wall finishes, selling at a figure out of all proportion to their actual value or cost. One of these can be produced on the following basis:—Grind 80 parts by weight of condensed French zinc white, green seal, in a vehicle composed of 10 parts of varnish made from white kauri gum (known as XXXXX) with only 10 gallons of oil to 100 pounds of gum), 3 parts of palest lithographers' varnish and 10 parts pure turpentine. This will produce 100 pounds soft paste base. Let it stand for forty-eight hours covered with some turpentine to keep from skinning over, then thin down with 24 pounds by weight of turpentine to the 100 pounds by weight of paste. This will give 7 6-10 gallons of mate-

rial weighing 16¼ pounds per gallon. By grinding calcined borax in varnish or pale oil and turps and adding as much as constitutes one-half pound of dry borax to the above batch, it will tend to make the material dead flat on drying. These flat enamels may be tinted to any desired effect with colors ground in oil if only small portions are required, otherwise the colors used should be ground in japan and thinned with turpentine.

CHAPTER XXVII.

WHITE AND COLORED ENAMEL PAINTS.

The term "enamel" is very much abused, as it is often being applied to any gloss paint. Properly speaking, enamel paints are or should be made to resemble in appearance the finish given to articles of metal that have been enameled by the furnacing process. Enamel paints are made in two forms—air drying and baking—but in either case cannot be produced by combining pigments with drying oils and drying mediums alone. Gum varnishes constitute an essential part of enamel paint, and the harder the resins or gums the better will be the wear of the resulting product. The old-fashioned way of making white enamel for interior decoration has been to grind French process zinc white in clear damar varnish, adding a small portion of anhydrous white sugar of lead, previously ground fine in bleached oil or in damar varnish, thinning the paste so ground with either damar or very pale rubbing varnish to a consistency that flowed well from the brush and leveled down uniformly onto the surface. This style of enameling was known as china glossing, and is still in practice for moderate priced work. In the chapter on grinding white bases for enamel paints we have pointed out that 70 pounds French process zinc and 30 pounds white damar varnish will, when ground on a water cooled mill produce the proper base for china gloss, and we may add that in order to produce good drying and hardness, ½ pound white sugar of lead, ground fine in oil or varnish, should be incorporated with this paste

base previous to reducing it with 14 gallons varnish that may be either damar varnish or a good white mixing varnish of approved quality, but in neither case must the varnish be too heavy in body, and above all the paste base must have an ample time to cool after coming from the mill. The quantities of base and varnish mentioned should produce 20 gallons of china gloss weighing not over 10 pounds per gallon, while the general run of interior enamel white average between 11 and 12 pounds per gallon when the pigment is pure French zinc. For interior white enamel that is to be rubbed and afterward polished, a hard gum varnish is required, because that made with damar varnish is most too slow and does not stand well when rubbing with oil and pumice, but requires rubbing with pumice and water. A high grade interior enamel white or porcelain finish that will stand rubbing with oil and makes a fine polished surface that cannot be surpassed can be made on the following formula:—Forty-five pounds French zinc in damar as above. 6 gallons palest hard rubbing varnish, 1 gallon pure spirits of turpentine. This will make a little over 9 gallons of enamel weighing 11 pounds per gallon. Beat the base up with the turpentine first, then gradually add the varnish. A trifle of Prussian blue will give a porcelain effect, but must not be overdone. The mixing of enamels must never be done in a room with a temperature below 70 degrees F., and all enamels must be carefully strained after mixing, having the apparatus clean as possible.

When it is desired to tint white enamel paints to certain color effects only the very purest and strongest colors should be selected and ground to the utmost fineness in oil or varnish, preferably the latter, when an appreciable

percentage is to be used. Before adding the color to the white base it should be thinned to the consistency of varnish and carefully strained. Colored enamel paints for interior work are best made from pure pigments ground fine in varnish that may be pale or dark, according to the pigment that is embodied with it. The colors selected should be free from any extending material and as light in gravity as possible. For instance, for black, the finest quality of carbon black; for red, pure toner of the desirable shade; for yellow, pure chrome yellow; for green, chemically pure chrome green; for blue, Chinese or Prussian blue are most preferable. One quarter pound of finest carbon black, dry, and a similar quantity of dry toner for red, ¾ pound dry chrome yellow, ¾ pound dry C. P. chrome green and ½ pound Prussian blue, dry, to make one gallon when thinned with sufficient varnish will be ample. A hard drying mixing varnish is sufficiently good enough unless the enamel paint is to be rubbed, in which case a rubbing varnish is required.

For a *Bathtub Enamel* the best base is a mixture of equal parts white lead and zinc white, and should be ground in oil and thinned with a good pale hard gum varnish as follows:—Forty pounds base as above, in oil; 6 pounds pure spirits of turpentine, 54 pounds varnish as above. This will produce an enamel of excellent body for tin or zinc lined bathtubs, the result of above formula being 8½ gallons.

Exterior or Weatherproof Enamel should be composed of the base described in the chapter on grinding the white bases for enamels as practiced in Holland; that is, grinding French zinc white in heavy bodied or highly oxidized pale oil and ageing the paste for some time

before mixing it with hard gum varnish. An exceptionally high grade of exterior white enamel can be made by grinding 65 pounds condensed zinc white in 28 pounds of the heavy oil and 7 pounds pure spirits of turpentine, permitting this paste to stand for a week or more, then placing same in a mixer, and to every 40 pounds of the paste add 60 pounds of varnish made from XXXX kauri gum at the rate of 12 gallons linseed oil to 100 pounds gum, the grinding of the zinc in the heavy oil furnishing elasticity and wear, the gum varnish the high gloss. This formula will produce 9 gallons weighing about 11 pounds. If this exterior enamel is to be tinted, oil colors will serve the purpose very well, but only such as are permanent to strong light must be selected.

Marine or Waterproof Enamels must have in their composition a hard gum varnish that has proven itself impervious to the action of water, and it stands to reason that linseed oil cannot be its chief constituent. It should be made of palest kauri gum, with not too large a proportion of oil, the pigment for a white enamel of this kind being composed of zinc white ground in linseed oil. Fifty pounds of this base mixed with 6½ gallons of the varnish would produce 8¾ gallons of paint. If the varnish does not make the paint dry sufficiently hard in reasonable time, a concentrated white drier may be used for part thereof to the extent of ½ or ¾ gallon. Colored marine or waterproof enamels may be produced with pigments of the desired color, ground in oil, reduced to brushing consistency with a mixture of 1 part japan drier and 9 parts hard drying water resisting varnish.

Baking Enamels are as a rule produced from pigment ground fine in fire boiled linseed oil and reduced for application with a hard gum varnish that carries a large percentage of oil. These enamels must flow out evenly, and when being stoved must not show any imperfections such as pin holes, brush marks, ridges, etc., which can only be prevented from appearing when the enamel is of full body. This body must be produced by the varnish, as it cannot be done by the pigment. As white lead cannot stand any high temperature in stoving (baking), the pigment must necessarily be zinc oxide or lithopone white for white baking enamel, and the oil, as well as the varnish, must needs be very pale. Damar varnish makes a good white baking enamel, but is rather brittle and very sensitive to chipping. A good formula for a white porcelain-like baking enamel for galvanized iron sheathing or tin that will not readily scratch or chip after baking for five or six hours at a temperature of 170 to 180 degrees F. may be made as follows:—Seventy pounds French process zinc ground in 30 pounds fire melted gum damar varnish as the base, thinned, after standing forty-eight hours, with 6 gallons pale gum varnish that requires thirty hours to dry if used by itself. This produces 11 gallons weighing a trifle over 13 pounds, and may be reduced at the place of operation with equal parts turpentine and damar varnish if desired. The white can be tinted to any desired effect. Colored baking enamels are made with pigments ground in oil and reduced with baking varnishes of more or less dark color.

The manufacture of *Black Baking Enamels* is essentially a problem for the Varnish Maker because to make them properly requires, that the asphaltums be incorporated with the oil, etc. by heat.

CHAPTER XXVIII.

LIQUID AND PASTE WOOD FILLERS.

When liquid wood fillers were first placed on the market, they were offered as a shellac substitute, soft woods, such as white wood (poplar), white pine and spruce being more largely used in building operations and furniture than they now are. Denatured alcohol was then not in use as now, and wood alcohol shellac varnish was not much favored for interior work on account of the ill effects on the operator's eyes and lungs. Thus the advent of liquid wood filler was hailed with enthusiasm by painters, and the material at that time was composed of far better material than is the case with most of it to-day. Sharp competition on the part of the manufacturers accounts for this. All sorts of mineral bases have been tried from time to time, silica and silex, china clay, magnesium carbonate, barium carbonate, talc or soapstone and even terra alba and starch.

A good liquid wood filler that will give satisfaction, but may be found rather high in cost to meet competition in some quarters, is prepared as follows, the batch producing 50 gallons:—

68 pounds best bolted English china clay;
22 pounds boiled linseed oil (not too dark);
10 pounds pale liquid drier;

100 pounds are mixed and run through a mill, then placed in a liquid paint mixer and the following liquids added to the thin paste:—

12 pounds pale liquid drier;
30 pounds spirits of turpentine;
308 pounds pale mixing varnish;

This will weigh 9 pounds per gallon, and if the clay has been thoroughly dried and is naturally unctuous, it should not settle hard in bottom of container. As a matter of precaution, however, one gallon of emulsion as described under Ready for Use Liquid Paints may be stirred into a batch of 50 gallons. As the quality of liquid wood filler depends to a great extent upon the quality of the varnish used in its preparation, a filler sold at low price must necessarily be made from lower priced material. For a filler of that sort the following will serve as a guide:—Grind 50 pounds asbestine powder in 30 pounds raw linseed oil, which will produce 80 pounds of soft paste, which reduce in a liquid paint mixer with 3 gallons pale liquid drier and 34 gallons pale gloss oil (rosin and benzine liquid) and 7 gallons benzine, resulting in a batch of 50 gallons weighing 7¾ pounds to 8 pounds per gallon, according to the body of the gloss oil.

Liquid Fillers and Stain combined are produced by simply adding to the liquid filler such colors as are described under varnish stains and in similar quantity per gallon.

Paste Wood Fillers must have the faculty of closing up the pores and interstices of more or less open grained woods in such a manner that while the surface so treated becomes non-absorbent, the natural beauty of the wood must not be obscured, and if the wood has been stained, the filler must not dull the transparency of the stain, or if the filler has been colored the filling material must not injure the richness or transparency of the color. Therefore, the more translucent the filling material the more valuable the product, and while barytes, whiting, clay and gypsum have been and are still employed for

the sake of cheapness, the very best material is pure silex or silica. Starch and dextrine have also been used, especially for holding the heavier minerals in suspension, but as these perish readily under the influence of moisture, their use is not recommended. When barytes is used in paste filler it is done with a view to lessen cost of production, as barytes requires not much more than one-third the weight of vehicle required by silex, talc or clay. The latter two pigments are too unctuous, whiting is too prone to show up white under varnish and terra alba or gypsum is too short and tends to cake hard with the vehicle in the containers. As a paste filler is thinned with turpentine or benzine, mostly the latter, and applied to the surface like a flowing varnish, and the excess of filler after its setting wiped off with tow, waste or excelsior, the vehicle in which the filler is ground must be so selected that the material does not work gummy and pull out of the grain. It is obvious that a japan containing rosin will not work properly along with the oil binder, and yet a strong drier must be used, as the filler is required to dry hard enough to sandpaper in twenty-four hours. Paste filler, light or natural, must be ground in a liquid of 4 parts raw oil and 1 part good grinding japan by volume. A good figure for a batch of paste filler, natural, is as follows:—125 pounds floated silex, 24 pounds raw linseed oil, 6 pounds medium grinding japan. When too stiff to go through the mill properly, add sufficient thin liquid drier or turpentine if not too high in cost. For colored fillers do not add colors in oil to above grinding, but use dry colors, as it will clean off the surface more readily.

CHAPTER XXIX.

IRON FILLERS AND MACHINERY PAINTS.

Iron fillers for surfacing castings and hiding the imperfections thereof are usually sold in paste form, so that they may be used as a plaster or putty, applying same with a wide spatula or broad knife, a sort of knifing-in operation and also as a brush coat when thinned with benzine or turpentine substitute. The color is usually a nearly jet black, but steel color is also used to some extent. While white lead was at one time the most costly ingredient in the steel colored fillers, it has given way to zinc oxide or lithopone, and very little of these enters into these paste paints. Black filler is the chief ingredient in most iron fillers, but some are based on barytes and whiting, with lampblack as the coloring principle. The vehicle is composed of raw linseed oil and strong liquid driers, with the latter predominating.

The very low price at which these goods are sold nowadays precludes the use of high grade japan driers.

A fairly good iron filler for use as a plaster putty in its paste form or as a brush coat when thinned with substitute turps or benzine can be produced on this plan, but is best made in a putty chaser:—Sixty-five pounds mineral black filler, 17 pounds common whiting, 8 pounds raw linseed oil, 12 pounds liquid drier (containing gum binder and benzine thinner), total 102 pounds, resulting in 100 pounds product. When this is to be applied to castings a portion of the paste should be thinned with benzine and a coat applied over all of the casting, otherwise the filler will not hold, and when the filler is applied with the spatula as a surfacer, it must be wet up some with benzine or turpentine, so as to level down smoothly.

Steel Color Machinery Paste Paints are thinned by the consumer with substitute turpentine or benzine, as the case may be, and applied with the brush, drying flat, thus hiding any imperfections that may be in the metal. They are as a rule furnished in several shades, light, medium and dark. The pigment usually consists of lampblack, barytes and whiting, or lampblack and whiting alone, with enough zinc oxide or lithopone to produce the desired shade. When the thinned paint is used for dipping, the best policy is to omit barytes entirely, thus avoiding precipitation of sediment. A medium shade of this form of steel color paste can be produced on the following plan:—Three pounds dry grinders' lampblack, 8 pounds lithopone white, 65 pounds Paris white, 10 pounds raw linseed oil, 16 pounds strong liquid driers, ground in one run through a 30-inch mill; net result, 100 pounds.

Machinery Gloss Paints or Enamels are bought mostly in the ready for use form, and when intended for decorative purposes on machine tools, looms, etc., they are simply colors ground in oil or varnish, reduced to liquid consistency with moderate priced mixing varnishes. When desired, however, for engine work in power houses and engine rooms, where a decorative effect is desired, higher grade goods are in demand. While in many places the work is done by the application of colors ground in japan, especially where the work is to be striped and finally finished in clear varnish, there is still a demand for engine enamels, and here the color must be ground in a suitable varnish and thinned with a varnish that is to hold its gloss under the effects of steam vapors and heat. It is essential to ascertain by tests what varnish will stand such conditions.

CHAPTER XXX.

PUTTIES AND CEMENTS.

Good putty for the use of painters and glaziers cannot well be made without the use of a chaser or edge runner mill, because only a thorough kneading will produce the proper mechanical union between pigment and oil. Strictly pure whiting and linseed oil putty consists of 85% by weight of whiting and 15 parts by weight of pure raw linseed oil. Exacting consumers, who do not consider first cost so much as wear and durability will specify linseed oil, whiting and white lead putty and the usual rule is to use, in the pigment portion, 10 per cent. by weight of pure white lead. 78 lbs. by weight of whiting, 8 lbs. by weight of dry lead and 14 lbs. by weight of linseed oil are the right proportions for this sort of putty. The batches are regulated as to quantity by the size and capacity of the apparatus and when the mixing is well made, the material is discharged from the chaser and placed on the floor in heavy layers to undergo, what is termed a sweating (or ripening) process, occupying several days and nights, when it is replaced in a chaser for a second operation of kneading, which is continued until the putty will not stick to the hands, when using. Unless so treated putty will not work well, nor hold well. Putty of this character can be obtained from reputable manufacturers, when the consumer is willing to pay the price, but over 90 per cent. of all the commercial putty sold by jobbers and dealers cannot be properly classed as linseed oil and whiting putty, most of it being made with non-drying oils, the

better grades with corn oil, others with so-called paint and putty oil, and in many cases, marble dust replaces part of the whiting. Oil foots are also used with putty of this class, that is made to supply the demand for cheapness, which has been fostered by the trade themselves by giving away putty when selling glass, thus creating an idea, in the minds of buyers, that putty is of no value. When putty of the quality last mentioned is used for glazing sash and closing up nailholes, it will not dry as it should, by oxidation, but simply hardens, in time, to a brittle mass and the slightest vibration will often make it lose its hold, crumbling out of its place.

Boiler Cement.

Boiler cement can be made by grinding 24 parts by weight each of dry white lead, kaolin (clay) and black oxide of manganese, all powdered in hard gum varnish (not manila gum), that does not dry in less than 24 hours of itself. It will require 30 parts by weight of varnish, the batch producing 100 parts by weight after grinding on a watercooled mill. It will stand hot water after hardening and high degrees of heat.

Roof Cement.

Roof cement for stopping leaks in tin and iron roofs is best made by boiling paint skins in raw linseed oil, until all the skins have softened, and when cooled somewhat, the mass is placed in a mixer, more dry pigment or oil is added as may be necessary and then run loosely through a paint mill. It should be in the form of a paste. Varnish bottoms with mineral pigment can be utilized in a similar manner.

Rivet Head Cement.

Rivet Head Cement or composition is usually made by grinding equal parts pure red lead and whiting in boiled linseed oil and japan, two parts of the former and one part of the latter. It should be ground to order only, on account of the hardening tendency of the red lead with drying oil and japan. It is best made in soft paste form, grinding say 40 lbs. dry red lead and 40 lbs. bolted whiting in 14 lbs. boiled oil through a mill and then adding in a mixer 7 lbs. japan.

If wanted in black, rivet head composition is made by grinding 10 parts by weight of white lead, 5 parts by weight of litharge, 50 parts by weight of black filler in 15 parts by weight of boiled linseed oil and 20 parts by weight of hard gum japan. A small percentage of lampblack added will give the composition more depth. As these compositions must dry flat, they must be prepared in a form stout enough to admit of thinning with turpentine or benzine.

PART V.

CASEIN AND COLD WATER PAINTS.

CHAPTER XXXI.

ORIGIN AND USES OF CASEIN.

For many years back it has been the aim of those interested in paint materials to devise a comparatively cheap coating for the exterior as well as the interior of buildings that did not have the defects of ordinary whitewash, nor those of kalsomine, something that could be prepared by the consumer on the spot without the aid of heat and without the necessity to apply the paint in the hot state.

That the curd of skimmed milk in combination with quick lime has great cementing properties has been known to the initiated for centuries and many old joiners still use this mixture in preference to glue for joining woodwork together. Many old formulas for water paints give skimmed milk as one of the chief ingredients, but so far as wearing quality of the coating is concerned, the recipes are not worth the paper they are printed on.

This, however, is not due to the presence of the milk as a binder, but to the form in which the milk is introduced.

The casein of cows' milk is composed of 53 to 54 per cent. of carbon, 7 per cent. hydrogen, 16 per cent. nitrogen, 22.5 per cent. oxygen, 8 per cent. sulphur and 85 per cent. phosphorus. It comes into commerce as a flocculent white powder that is nearly insoluble in water, but nearly soluble in hot alcohol. By the addition of soda, borax, quick lime, water glass, etc., in fact, with any alkali, it becomes wholly soluble in water.

The difference between casein and other albumens lies in the fact that casein contains a small percentage of phosphorus, as above noted.

While casein interests us only for its utility as a binding medium for paint, there are numerous uses for it in other lines of trade, such as imitations of articles usually made of celluloid, ivory, etc., for forming plastic figures, apparatus, also for glazes of confections and the like, where it does not collide with the pure food laws.

It is difficult to produce casein that is absolutely free from fat and calcium phosphate. By the use of a mineral acid, especially acetic acid, casein is precipitated out of milk or out of casein salts. This is important, when the casein is to be used as the binding medium in cold water paint. When solutions of casein are heated by the addition of caustic lime the casein is precipitated in insoluble form, but the simplest method is to precipitate it by the addition of a mineral salt.

Value of Casein as a Binder in Paint.

However, in the manufacture of cold water paint, the casein must be soluble in the usual way and in order to make the paint most resistant to moisture and water the addition of formaldehyde is resorted to, which also acts as a disinfectant, wherefore such paint is especially adapted for the interior of hospitals, schools, sanatoriums, etc., but great care must be taken in adding the formaldehyde, otherwise the casein may be thrown out of the paint, thus leaving it without binder. The addition of formaldehyde is protected by letters patent and there are any number of other patents on cold water paints and on casein, though none of them vary con-

siderably, excepting as to the method and means of precipitation, while all of them agree that casein is produced from skimmed milk.

Processes for Making Casein.

To relate the various processes would be carrying coal to Newcastle, so we will confine ourselves to the description of a few of the more interesting.

U. S. Patent No. 745,097 and German Patent No. 135,745 are almost identical in the method of producing a casein that is practically free from fat, at least, it answers all practical purposes in that respect. It has been ascertained by chemical analysis that skimmed milk usually contains 2 to 3 per cent. fat, so that casein made from the untreated milk would contain 6 to 8 per cent. fat. The patent claims are that a casein free from fat can be obtained by mixing the skimmed milk with alkalies and separating the fat by passing the mixture through a centrifugal apparatus, after which the casein is precipitated in the usual manner by the treatment with acid. In order to separate the fat from the milk more readily, the milk and alkali mixture is warmed before passing it into the centrifugal machine. The precipitate is collected, washed, pressed and dried or used, as the case may be, in paste form after washing and pressing.

Another patent describes a process in which sulphurous acid is used for precipitating casein from the milk. The milk is brought to a temperature of from 130 to 160 degrees Fahrenheit and, while being agitated in a covered tank with stirring device, the acid is run in. It is

claimed that, by this method, the precipitation takes place more promptly and more completely than by any other.

Bichamp says that a pure casein, free from ash, may be obtained by precipitating skimmed milk in the cold way with acetic acid. The precipitate is washed several times and ammonium carbonate added, until alkaline reaction takes place, when acetic acid is again used to neutralize.

Variety of Uses for Casein.

Before we consider the manufacture of cold water paints from casein it may prove of interest to some of our readers to learn the various and manifold uses casein is serving in the industrial world.

In the manufacture of certain foodstuffs, in calico printing, in soapmaking, in paper manufacture and others too numerous to mention, in fact, where animal glue was formerly indispensable it is now being used almost exclusively. We must not pass by without considering the great value of casein in cements for porcelain, chinaware, earthenware, glass and stone.

W. A. Hall claims that a fire resisting cement can be produced with a mixture of casein, phosphate of soda and sodium sulphite, to which is added some pulverized air slaked lime. A well known cement putty is made from cement in dry powder, brickdust or ground quartz, mixed with casein. A small portion of air-slaked lime will improve it. It can also be made from the curd of skimmed milk and sifted air slaked lime with the same dry ingredients, omitting the casein.

For mending fractures in porcelain, glass, etc., the best cement is made by dissolving casein in silicate of

soda (water glass). A preparation from casein, that is at the same time antiseptic as well as water resisting, is made by using borax in dissolving the casein. This is used for sizing fabrics, which are placed in the solution and after removing therefrom and while still wet, are given a coating of a weak solution of tannic acid, which renders the casein insoluble in water.

For paper and paste boards, etc., a good size can be made by dissolving casein in a solution of borax and the addition of liquid ammonia. Must be done with the aid of heat.

CHAPTER XXXII.

TESTS FOR COLD WATER PAINTS.

Physical properties of cold water paint should be tested for spreading and covering power, for free working under the brush and drying property, for resistance to moisture and water, atmospheric conditions, heat and behavior when mixed with coloring matter and last, but not least, the quantity of water required to reduce a given weight of cold water paint in the dry or paste form to brushing consistency. These tests are not as important to the user or consumer of cold water paint as they are to the manufacturer, because the trade expects that he or his agents know all about the various requirements, otherwise they will not have the confidence of the purchaser, nor will they be enabled to meet claims of disappointed consumers with any degree of certainty or belief in their explanation, should by any chance the material not come up to their claims or fulfill the expectations of the user or his patrons. It goes without saying that cold water paints will not meet any and all conditions of surface, otherwise very little oil or varnish paints would be sold and used. To test spreading and covering power of cold water paint it is only necessary to weigh out a certain quantity, say one pound of the dry powder, when sold in that form, place in a clean pot, adding enough cold water and stir until a medium paste, free from lumps, is formed. This is allowed to stand, say about 30 minutes, although it is beneficial to stir it several times during that period. Then the mass is well stirred with sufficient water, until it has assumed the consistency

of an oil-paint ready for the brush, when the quantity of water used is determined by weight. A good cold water paint with casein binder should require one and one-half pints ($1\frac{1}{2}$ pounds) of water for every pound of dry paint. When the cold water paint is sold in paste form, it is only necessary to weigh out a certain quantity of the paste, reducing it with cold water and when of the right consistency, determine, by reweighing, how much water has been required. To ascertain spreading and covering power, a given quantity of the paint is applied on a plastered wall or suitable wooden surface in the same manner as it is done in practice. One pound of good cold water paint, ready for application with the brush, should cover at least $2\frac{1}{2}$ to 3 square yards, unless the surface be very rough and porous.

The working property of the paint is best tested on different surfaces, on smooth and rough plaster, on smooth and rough wood, also on brick and stone and with suitable brushes in a normal temperature, not below 60 degrees Fahrenheit. The drying of the paint of course, depends on the porosity of the surface, as it will set much more rapidly on absorbent than on close, non-porous material. To test cold water paint for resistance to atmospheric influences, it is best to apply several coats on cement, as well as on lime mortar plaster, with exposures to the south as well as to the north and it is well to have this done in winter and in summer also. The observation should be conducted at least for two months in summer and three or four months in winter. To try its resistance against water the painting tests should be flushed with water from time to time.

The trial of the paint for resistance to heat is best tested by coating wall spaces near radiators or heaters, stoves, ranges, etc., making frequent observations as to the appearance of cracks, blisters or scales. Of course, the surface, where such tests are made, must be in perfect condition. If then cracking, blistering or scaling is not apparent, the paint has sufficient heat resistance. The test can also be made by coating sheet iron Nos. 18 or 20, and submitting same to a temperature of 212 to 240 degrees Fahrenheit in drying ovens for a few days. When after the iron has cooled the paint does not show cracks or blisters or does not scale, it is sufficiently heat resistant. As to miscibility and behavior with color cold water paints in colors or tints can be prepared only with limeproof or alkali proof colors, and the base used for colored paints must necessarily have a greater portion of casein binder in its make-up than is used for the ordinary paint that is neither a white nor a colored paint of great body. The process of manufacture of casein cold water paint is on the whole rather simple. The chief requisite is a good mixing and sifting apparatus, which will turn out appreciable quantities of dry paint in a day's time. As has been stated, it is necessary for the solution of casein to add an alkaline salt. For economic reasons it is best to use for this purpose calcium hydrate (hydrated lime) in powder form. This is at present prepared on a large scale in special machinery, where the output warrants such. But for preparing it on a smaller scale, it is only necessary to spread fresh burnt lime out on a clean floor, where it is sprinkled with water from a hose with fine spray nozzle. In a few minutes the lime falls into powder, while emitting carbonic acid. When the reaction is over and the hydrate sufficiently cooled, it is

sifted in a cylindrical sifting machine for the protection of the workmen. If the calcium hydrate is to be transported it is packed in paper-lined barrels to keep it from contact with the air, which would make it unfit for use in dissolving casein on account of its avidity for moisture. The relation of lime and water in the hydrate is usually 10 parts by weight of water to 33⅓ parts lime, and the composition of casein cold water paints is alkali soluble casein, calcium hydrate or another alkaline salt and a mineral pigment, varying according to the idea of the maker, also white and colored pigments.

It is not absolutely necessary to use alkali soluble casein, excepting as noted above for economical and practical reasons in the manufacture of cold water paint. When water soluble casein is used the material contains the necessary mediums or additions for the purpose. Such additions are usually borax or bicarbonate of soda, very seldom calcium hydrate.

CHAPTER XXXIII.

MANUFACTURE OF COLD WATER PAINT.

Pigments Most Suitable in Cold Water Paint.

The basic mineral pigments in cold water paints are usually chalk (whiting), kaolin (china clay), magnesium silicate or alumina. The chemical examination of a popular brand of cold water paint resulted as follows: Organic matter, 15.5 per cent; calcium carbonate, 15.6 per cent.; insoluble silicates, 40.5 per cent.; alumina, 26.0 per cent.; water of combination, 2.4 per cent. Dissecting this report it will be good logic to say that the mineral matter consisted of an alumina silicate, presumably kaolin or white pipe clay, while the calcium carbonate was introduced in the form of calcium hydrate in order to dissolve the casein, which is found in the analytical report under the caption of organic matter. The combined water belongs partly to the alumina and partly to the calcium hydrate. There was an entire absence of chalk or whiting, which in itself is rather in favor of the paint, because the presence of calcium carbonate in the form of chalk or whiting is not favorable to the wear of the paint in a locality where sulphur gases prevail. There is a difference of opinion among authorities on the subject as to whether whiting or white clay is best for pigment in cold water paint, but as a rule, economy in cost would favor the former, so long as technical objections are not considered. Ordinary white clay is not to be recommended, as there is always more or less risk of the cracking and scaling of the painted surface when such pigment is introduced.

Finally for colored casein or cold water paints the coloring matter requires serious consideration. These pigments must not only be alkali proof, but should also to a great degree be light proof and, besides containing no free acids, must be ground impalpably fine and be bone dry. In addition these colors should have the maximum staining power, because the rule is that the percentage of coloring matter introduced should not be over 30, while the base pigment in a colored paint should not be under 70 parts by weight. That all pigments entering into the paint must be bone dry is important, because if any moisture in the pigment is present, lumps, both large and small, will form in the package and, becoming hard, will not readily dissolve on mixing with water and will give the paint a streaked appearance. The use of colored pigments that are not entirely free from acid, as may be the case with artificial oxide of iron reds, or with chemical pigments that are imperfectly washed, is liable to produce blistering of the paint during application, due to a reaction between the free acid and the alkaline salt that is present with the binder. The colors that will answer in casein paints are rather limited and consist principally of the following:—

For Blue.—Ultramarine (lime proof) blue and imitation of cobalt blue.

For Yellow.—All yellow ochers, raw sienna, chrome yellow, Indian yellow, and some of the latest coal tar derivatives, as lithol fast yellow, chinazol and naphthol yellow S.

For Orange.—Chrome red in several shades for orange chrome, very deep hues, and autol fast orange with naphthol yellow for the lighter shades.

For Red.—Orange mineral, red oxide, Venetian red Indian red, caput mortuum and lithol red R and G, also autol fast red, lithol claret R and B, etc.

For Brown.—Umber, raw and burnt, burnt ocher, burnt sienna, manganese brown.

For Green.—Oxide of chromium green. Cobalt green, ultramarine green, green earth, also lime greens made from best green earth and colored with Malachite green and brilliant green.

For Black.—Carbon black, vine black, ivory or bone black, best mineral black.

For White.—When the ordinary mineral pigment together with the calcium hydrate does not produce sufficient whiteness and hiding power:—Zinc oxide, lithopone and blanc fixe.

The colors given in the foregoing list will, in proper admixture, produce any tint or shade that may be required in cold water paint, and whenever the color named appears too expensive, it may, if strong enough in staining power, be cheapened by employing more colorless mineral base.

Whenever a solid color (not a tint), is desired, the colorless mineral base only is used, but when a good lively tint is wanted it is of advantage to add zinc oxide or lithopone or even blanc fixe to give solid appearance and sufficient hiding power to the paint, especially where transparent coloring matter is used.

The composition of casein paints does not vary to any great extent. The chief value in this material lies in its proportion of casein, which even in the cheapest commercial brands is not below 10 per cent. by weight of the total and has been found in some as high as 20 per cent.

When, however, it goes over this figure, then additions of whiting or china clay are made by the consumer before using it.

Formulas for Casein Paints.

The following formulas will give an idea of the commercial brands on the market as sold in the dry powdered form:—

Branded White.

10% Casein, alkali soluble,
5% Calcium hydrate,
85% Calcium carbonate,

20.20% Casein, alkali soluble,
12.00% Calcium hydrate,
67.75% Calcium carbonate,
.25% Ultramarine blue,

20% Casein, water soluble,
80% Calcium carbonate,

15% Casein, alkali soluble,
10% Calcium hydrate,
40% Calcium carbonate,
35% Kaolin.

In these as well as the following formulas calcium carbonate (whiting) and kaolin can be used either alone or in varying proportions in combination.

Red.

15% Casein, alkali soluble,
8% Calcium hydrate,
67% Calcium carbonate,
10% Oxide of iron red.

Blue.

10% Casein, alkali soluble,
6% Calcium hydrate,
69% Calcium carbonate,
15% Ultramarine blue.

Green.

10% Casein, alkali soluble,
6% Calcium hydrate,
40% Calcium carbonate,
34% Kaolin,
10% Chronium oxide green.

Brown.

15% Casein, alkali soluble,
10% Calcium hydrate,
55% Calcium carbonate,
20% Burnt umber.

Yellow (Buff)

10% Casein, alkali soluble,
6% Calcium hydrate,
70% Calcium carbonate,
14% French yellow ocher.

Sandstone.

15.00% Casein, alkali soluble,
10.00% Calcium hydrate,
73.00% Calcium carbonate,
1.75% French yellow ocher,
.25% Vine black.

Greenstone.

15.00% Casein, alkali soluble,
10.00% Calcium hydrate,
68.00% Calcium carbonate,
3.00% French yellow ocher,
1.75% Chrome yellow, D,
.25% Vine black,
2.00% Limeproof green.

Black.

20% Casein, alkali soluble,
12% Calcium hydrate,
48% Kaolin,
20% Mineral black.

Gray.

As above, but decrease black to 5%, and increase kaolin to 63%.

In the manufacture of casein cold water paints for interior work, as in churches, theatres, hospitals, sanatoriums, schools, etc., a great selection of color is at our command that could not be used for exterior painting. Therefore a great many varieties of color effects may be obtained. It is a fact well known that casein cold water paints are claimed to be washable, but this is true only of some brands and here only in a limited sense. For if these coatings were washed with water daily for a number of days, they would be ruined in a short space of time. Trials have been made to prolong the life of the paint and these were partly successful. The casein paint coatings were given an additional coating with a solution of alum in water, which proved satisfactory on interior walls, but not outside of buildings. Further trials with formaldehyde proved this rendering the casein insoluble on the drying of the paint and there are now any number of letters patent protecting the various methods by which this end is attained.

Use of Casein in Decoration and Art Painting.

Pictures that are painted with casein colors are exposed to the vapors of formaldehyde, which treatment renders them insoluble in water. But inasmuch as this treatment is impracticable for large surfaces the

practice is to add a certain percentage of formaldehyde to the ready for use paint immediately before application. To heighten the efficiency of the paint in this respect it is recommended to add to the water used for washing or cleaning of the surface, a small portion of solution of formaldehyde.

While casein cold water paints are much more economical in first cost and on account of the disinfectants introduced really more sanitary for the walls and ceilings of hospitals and other public institutions, it would be fallacy to expect that they are equal in wear and durability to enamel paints or varnish. But for the purpose mentioned it must be said in favor of water paint that after its drying there is still a certain degree of circulation of air that is not the case where enamel or varnish is used.

When casein paints are used, be it for interior or exterior work, it is an absolute necessity that the surface is dry and that there will be no moisture before or after applying the paint. Ordinarily the surface should be somewhat porous, as the paint will not cover well or hold well on very smooth, glossy surfaces. Hence any kind of masonry, be it stone, brick, terra cotta, concrete or cement, also wooden girders, joists, in fact, any sort of timber may be successfully coated and made to some extent fire resisting. Lately casein paints have been placed on the market that contain certain percentages of linseed oil, and are recommended for painting iron and steel, claiming for them rust preventing properties. The makers, however, are very careful to direct that the surface must be entirely free from rust before it is coated, a caution that holds good for any iron and steel protective paint.

CHAPTER XXXIV.

USES OF CASEIN AND COLD WATER PAINTS.

The decorators, who formerly used the better grades of glue and gelatine for their distemper and fresco material, have made progress in the use of casein, but they require far better material than the cold water paints described in the foregoing. While for ordinary painting the alkaline soluble casein is dissolved by the aid of the cheaper calcium hydrate, the decorator will use the water soluble casein and depend upon spirit of ammonia or solutions of borax, bicarbonate of soda or waterglass to effect the solution. For special purposes emulsions of wax or oil are sometimes added. There are certain precautions which the decorator must not be unmindful of and that is, when the surface is lime plaster, it should first be coated with diluted skimmed milk, while cracks or scaled parts must be filled up. Water stains or spaces previously whitewashed or kalsomined should be treated with alum size. For fresco painting the ground work must be especially well prepared. Every coat of plaster must be thoroughly dry before the next is applied so that not a trace of moisture can be present. The colors that are safe in use with casein in fresco and distemper painting are as follows:—

Red.—Oxide of iron, Venetian red, Indian red, carmine, alizarine lake, chrome red, English vermilion, French orange mineral (Tour's brand), also the latest azo reds.

Yellow.—Cadmium yellow, French ocher, chrome ocher, chrome yellow, Dutch pink, raw sienna.

Blue.—Artificial ultramarine blue and imitation cobalt blue.

Green.—Oxide of chromium green, Guignet's green, ultramarine green, terra verte, Verona green, mineral green.

Brown.—Burnt Turkey umber, burnt ocher, burnt Italian sienna, manganese brown. Vandyke brown is not recommended.

White.—White lead, lithopone, zinc white, blanc fixe.

Black.—Ivory or bone black, carbon or lamp black, vine black.

A varnish that many take for a substitute for linseed oil varnish is known as casein varnish, but it is an error to think that this solution of casein in water will take the place of oil varnish. These products, under whatever name they may appear in the market, are simply solutions of casein in liquid ammonia, borax or sodium bicarbonate, waterglass or caustic soda lye, to which are sometimes added emulsions of soap, rosin or wax, turpentine, etc., to make the so-called varnish dry more rapidly and more elastic. It is applied to surfaces where the natural color of the material is not to be changed by paint, as a cheap coating to give temporary protection, though some may believe that it will exclude moisture permanently. The cold water paints on the market that are sold in this country and in Europe under fanciful names number hundreds, not to say thousands, and it is astounding to see the claims put forth in the specifications for letters patent. This does not mean, that all the cold water paints consist of casein as the

binder, the brands containing animal glue are also quite numerous, especially those sold in the American market.

The dry kalsomine paints that contain glue must be dissolved in boiling water, but they are nearly, if not entirely obsolete. It may interest some of our readers to learn that casein is being used as a fixative for insoluble dyes in calico printing. The casein is dissolved in lime water for this purpose and so used.

In conclusion we would point out that casein has obtained vast importance as a substitute for celluloid. While the latter is combustible in the extreme, casein does not readily take fire. The methods of manufacture are protected by a series of patents. Due to its high insulating properties, as also to the fact that it can be worked in the cold condition and formed into any shape after softening in hot water, its uses in this connection are almost unlimited.

PART VI.

PRACTICAL RECIPES AND WORKING FORMULAS.

Aluminum Bronze Paint in Liquid Form.

For Exterior Surfaces:

I This may be made by mixing the aluminum bronze powder with the celluloid bronzing liquid (so-called banana oil) at the rate of 18% by weight of the powder and 82% by weight of the liquid, resulting in a yield of 12 gallons liquid bronze, after allowing for waste and evaporation, while mixing.

II Another method of production is to make the celluloid liquid on the following plan: Purchase waste cuttings or chips of celluloid, selecting only those, that are not dyed, but either translucent or at most a milky white, dissolving them in wood alcohol, amylacetate and refined fusel oil, then adding the powder as in I. 3 pounds celluloid chips are dissolved in 60 pounds by weight of 95% wood alcohol or 188° denatured alcohol, 20 pounds by weight of amylacetate and 5 pounds by weight of refined fusel oil, the last named being added when the chips are dissolved. Result 12 gallons liquid, with which is mixed 15 pounds fine aluminum bronze powder, yielding 12¾ gallons liquid bronze paint.

For Interior Surfaces on Wood or Metal Brush Work:

III The odor of the so-called banana liquid being unpleasant to many persons and difficult to get rid of for some time, a lustrous and very durable aluminum liquid bronze paint can be made by mixing 16 pounds of the finest bronze powder with 60 pounds of a pale mixing varnish of the China wood oil type, that contains heavy petroleum naphtha (the so-called turpentine substitute) for solvent, and 26 pounds 62° benzine.

This batch will yield about 11 gallons, allowing for waste and evaporation in mixing.

For Dipping Metal, such as Tin or Galvanized Iron:

IV Mix 15 pounds of the finest and most lustrous aluminum bronze powder obtainable with 55 pounds of pale mixing varnish, of the China wood oil type, as in III and add 15 pounds 62° benzine and 15 pounds 90% coal tar benzol, or well refined solvent coal tar naphtha, but avoid the use of solvent naphtha with a strong gaseous odor, as this is liable to give trouble, when the liquid bronze is put up in sealed cans or jars for any length of time. This batch will yield 12 gallons of liquid bronze, that will drip freely from the metal dipped into it without sagging or running.

Note. When aluminum liquid bronze is to be applied over oil or varnish paint, it is best to use that made on form III whether it is inside or outside, as those made in forms I and II are very apt to lift the paint, because of the strong action of the solvents in those liquids.

Anti-Fouling Paints or Compositions for Ships' Bottoms.

The best formula believed to have been designed so far for an anti-fouling paint for the bottoms of steel ships or boats is based on ferric oxide in very fine division with a portion of zinc oxide, arsenic and red oxide of mercury in a vehicle of an alcoholic solution of shellac, with addition of pine oil. Linseed oil or fat varnishes must be avoided, as these promote marine growth in spite of the presence of poison. Anti-fouling

paints must be lighter in gravity, than the non-corrosive paints over which they are applied, yet must not act as solvents for the latter.

Anti-Corrosive or Non Corrosive Coatings for the Bottoms of Steel Ships.

The first coating for this purpose is usually dry red lead mixed on the spot with raw linseed oil and, in the opinion of the author, nothing better can be devised. However next to the red lead a non-corrosive coating is required, that will, in a measure, not only protect the red lead from being affected by the sea water, but also give a solid base for the anti-fouling coating. This must be a paint, that is neutral and impervious, free of pinholes and other imperfections, and the very best for the purpose, that can be produced is of the following composition: 50 lbs. sublimed blue lead, 12½ lbs. zinc oxide, (American), 17½ lbs. English cliffstone Paris white, ground in 20 lbs. heavy bodied linseed oil, (oxidized oil without drier) to form the base. One hundred pounds of this base, that may be colored with pure Indian red to make a sort of chocolate color is thinned with equal portions of raw linseed oil, turpentine and hard gum varnish to brushing consistency.

Anti-Fouling Composition for the Bottoms of Steel Ships.

The very best composition for this purpose so far designed is one that is based on an alcoholic solution of shellac and pine tar oil for vehicle, and finely ground ferric oxide of iron as pigment, with red oxide of mercury as the insecticide. The mixing formula is as follows: Dissolve 25 lbs. gum shellac T. V. or V. S. O. in 14

gallons alcohol 95% (denatured will do). Grind 25 lbs. zinc oxide American process and 25 lbs. dark Indian red (96% Fe_2O_3) fine as possible in 15 lbs. each pine tar oil and Venice turpentine, adding 10 lbs. mercuric red oxide on the last run, and add this to the shellac solution, mixing the ingredients thoroughly and straining through a fine sieve. This will produce 19 gallons of paint. However, under existing conditions, it will not be a paying venture for paint manufacturers to introduce anti-fouling compositions upon the market in this country at least, as naval authorities are very skeptical as to the merits of this line.

Asphaltum Paints and Asphaltum Compositions.

So called black asphaltum paints are often simply benzine asphaltum varnishes with or without admixture with coal tar. While the name asphaltum paint has become a synonym for something very cheap in the line of black paint, it need not deter the paint maker from placing a good article on the market. A good elastic black paint can be made by mixing 10 pounds grinders' lampblack in oil with 2 gallons raw linseed oil and ¼ gallon liquid dryer, with 11½ gallons benzine asphaltum varnish, thus producing 15 gallons black paint, that will stand exposure to the weather very well. An asphaltum composition, that is insulating and capable of resisting high degrees of temperatures is made by melting in an iron kettle 200 pounds gilsonite asphaltum with 40 pounds candle tar, and adding 30 gallons 160° coal tar benzol or solvent coal tar naphtha and 50 gallons 62° benzine for a 100 gallon batch.

Blackboard Slating.

Blackboard Slating Liquid can be made in several ways. When it is desired in such form, that after the application of several coats the board may be written on with soapstone pencils, the following formula will answer:

In a suitable apparatus, mix 3 pounds drop black and ½ pound ultramarine blue, both ground in oil with 3½ pounds washed emery flour and 12 lbs. coach japan, preferably made on a gum shellac base and when well beaten up, thin with 6 pounds gum spirits of turpentine, strain through a fine sieve and put up in well sealed cans or jars. The yield of this batch will be 2½ gallons.

Another formula, which however will not produce a slating for pencils, but a very good one for school crayons, is as follows:

Take enough from one gallon of denatured alcohol to triturate 3 ounces dry lampblack and 5 ounces dry ultramarine blue. In the balance of the alcohol, dissolve one pound orange shellac; add to this the triturated black and blue, also ½ pound rotten stone and ¾ pound pumice stone both in fine powder, mix well, strain and bottle.

Cements for Various Purposes.

Paste Cement for Fixing Metal Letters on Glass. To be used by specialist in doing this work, the material is ground in putty like form and put up in one or two pound tin cans for easy carriage. Grind 70 lbs. dry white lead and 15 lbs. bolted English cliffstone Paris white in a mixture of 10 lbs. refined or bleached linseed oil and 5 lbs. white damar varnish. The user wets this

paste with a little turpentine and fills the hollow part of the metal letter and places it on the glass.

Casein Cement for Filling Holes and Interstices in Stone. Mix 10 parts by weight of casein, 40 parts slaked lime and 40 parts fine sand and enough mineral color to match the stone with sufficient water to form a paste.

Cement for Uniting Stone to Stone, Glass to Iron, etc. Make a paste of powdered litharge and glycerine and use immediately, as it hardens rapidly. This is a very good aquatic cement.

Cement for Marble, Tiles, etc. Mix by measure 2 parts of white Portland cement, one part air slaked lime and one part powdered litharge with enough silicate of soda of 33° Be strength to make a thin paste.

Copper Paint for Wooden Ship's Bottoms.

This is usually wanted in brown or copper color and the most effective paint known for the purpose contains 5 pounds copper oxide in the form of fine scales, although it has been made with what was known as cement copper, which however contains as much as 25% other mineral, such as silica, clay, iron oxide, etc.

The following formula produces a very high type of such a paint, preventing the adhesion of barnacles and formation of marine growth.

40 lbs. Mineral Brown or dark native red oxide;
5 lbs. copper scales in fine division;
30 lbs. refined pine tar;
12 lbs. shellac japan;
13 lbs. heavy petroleum spirit;

100 lbs. or 9 gallons of paint.

Note. Linseed or other vegetable oils must be avoided as forming part of this type of paint, excepting the very small portion contained in the shellac japan, because the presence of appreciable percentages of vegetable oil will promote marine growth.

Copper Paint, so-called, for Yacht Bottoms.

Brown color is very seldom desired here, the favorite colors being green and bright red. The insecticide here need not necessarily be copper, but can be mercuric chloride (corrosive sublimate) or mercuric oxide (red oxide of mercury), either of which, of course, is much more expensive, than the oxide of copper, but being more active, less can be used in proportion, and the selling price of yacht compositions being higher, the maker can afford their use.

Formulas for First Class Yacht Compositions.

Green: Grind 10 lbs. chemically pure chrome green, dark shade, 30 lbs. blanc fixe (precipitated barium sulphate), 2½ lbs. to 3 lbs. powdered corrosive sublimate in 15 lbs. refined pine tar, as fine as possible, and thin the resulting paste with 30 lbs. of hard gum (preferably kauri) varnish, containing a minimum of oil and heavy petroleum spirit as solvent and add to this 2 gallons of the heavy benzine, known to the trade as substitute turpentine. This batch will produce about 9 gallons of paint.

Red: Grind 9 lbs. strong red oxide, 95% Fe_2O_3, 1 lb. pure para toner, blueish, 20 lbs. blanc fixe, 10 lbs. bolted whiting (English cliffstone), 2½ to 3 lbs. red

oxide of mercury or corrosive sublimate in 16 lbs. refined pine tar as fine as possible, and thin the resulting paste with 8 lbs. shellac japan, 24 lbs. of hard gum (preferably kauri) varnish with a minimum of oil and heavy petroleum spirit as solvent and add to this 1½ gallons of heavy benzine, yielding 9 gallons of paint.

Damp Proof Liquid, Clear and Colored.

50 pounds air slaked lime, 12½ pounds sugar or glucose, and 2½ pounds alum are mixed with 10 gallons warm water, until sugar and alum are fully dissolved. Then 18 pounds boiled linseed oil and 6 pounds oil of eucalyptus are mixed with the solution and the resulting liquid may be still further thinned with water. When pigment is to be incorporated with the damp proof liquid, use zinc oxide for white, about 2½ pounds to the gallon; for buff add sufficient yellow ocher to the white; for stone, yellow ocher and a trifle of raw umber; for drab, raw Turkey umber; for blue, add simply lime proof ultramarine blue to the liquid; for green, add yellow ocher to the last named and for red, add native red oxide.

Dead Flat Finish, Quick Drying.

Dissolve 2 parts by weight of gum sandarac in 7 parts by weight of ether. When solution is complete, add 7 parts by weight of 90% benzole. If the finish is to be black, dissolve 2% of the total weight of nigrosene B (spirit soluble) in the ether and sandarac solution, before adding the benzole.

Engine Enamels for Cold and Heated Parts.

To manufacture enamel paints for the cold parts of engines is not a difficult task as it is only necessary to select a vehicle, that will, on the drying of the paint, make it an easy matter to wipe off any lubricating grease or machinery oil without injury to the gloss. As engines are usually made of smooth castings and these well filled and surfaced, any well ground color of the desired shade will answer for the ordinary decorative enamel, when reduced to brushing consistency with a good mixing varnish, the percentage of color required depending upon the shade desired. Thus for a black enamel, 4 oz. of best grade carbon black, ground in oil may be added to one gallon of a quick drying mixing varnish, and will then cover, while it would require about 3 pounds of English vermilion to obtain fair covering. To produce a tinted enamel for engines, such as a warm gray, would require 5 lbs. zinc in oil or varnish tinted with lampblack and a trifle of yellow to one gallon of the mixing varnish and so on.

Unless specified, no paint maker of the present day would undertake to use English vermilion or orange mineral and eosine vermilion in this connection, as he has the red toners of the paranitraniline type at his command, one half pound of which, if pure, will when ground in varnish and added to enough mixing varnish to make one gallon of paint, cover very well over a suitable priming coat or ground.

When it comes to enamel paint for the heated portions of engines, the matter of preparing same is quite different, the material being much higher in cost and requiring caution in selection, when it comes to such colors as green, red, blue, etc. The temperatures being

rather high, heat proof colors must be selected and the varnish must also be one, that will bake hard and yet retain its elasticity under the extreme conditions of heat and cold. Green oxide of chromium is really the only green pigment, that will withstand this, so that an olive or bronze green enamel can be made by mixing enough carbon black with chrome oxide green to produce the effect and if needed, a small portion of alizarine red lake will assist in producing the proper tone. But in selecting the chromium oxide green, that known as Guignet's green must not be used, as high temperatures will destroy its fine color by removing its water of hydration. Toluidine red is a fast red, that is heat and alkali proof, and while very high in price, when chemically pure, will stand reduction with best china clay or infusorial earth, so as to bring cost within competitive limits. Imitation of cobalt blue, will stand quite high temperatures without change, and if a small portion of zinc oxide can be added without obtaining too light a shade of blue, will be the best pigment for a blue engine enamel. Whether these heat proof enamel paints are made in the solid colors or in tints on a base of zinc white, they should not be made to air dry too rapidly, not under 24 hours in the ordinary temperature of a room, otherwise they will not last.

Floor Crack Filler or Joint Cement.

The very highest grade of floor crack filler, that is practically colorless, but may be colored to match the finish that is to be applied, is made by grinding a good grade of perfectly dry cornstarch in a mixing varnish of the following composition: 165 lbs. hardened rosin are melted in a copper kettle, and when done, 30 gallons strong boiled

linseed oil introduced and kept at a simmernig heat until 30 lbs. beeswax (pure country yellow) is also dissolved, when kettle is removed from fire to the thinning room, where 45 gallons spirits of turpentine, that is added, will yield 95 gallons of a vehicle, that cannot be excelled by any other for producing an unshrinkable crack filler, when mixed with enough cornstarch to make a paste of the consistency of soft putty. A trifle of raw Italian sienna will give it the color of light oak on drying. In making the varnish, hardened rosin may be replaced by melting 150 lbs. F. rosin and introducing 15 lbs. air slaked builder's lime, treating it until well fused, before the oil and wax are added.

When dark color is not objectionable and rapid setting and hardening is desired, the cornstarch may be ground in a shellac japan of the following composition:— 40 gallons vanish makers' raw linseed oil and 30 pounds orange shellac V. S. D. are combined in the usual way, in a kettle of suitable size, and fused with 100 pounds varnish makers' red lead, 10 pounds litharge and 15 pounds precipitated black oxide of manganese and held over the fire, until the usual test for japan is had; when the batch has cooled sufficiently, 70 gallons of spirits of turpentine added in the thinning room and the result will be 110 gallons of grinders' shellac japan. When, for any reason, the cost of this is too high, use equal parts turpentine and heavy petroleum naphtha for thinning.

There are other crack and crevice fillers, but these are home made and do not interest the paint maker, because they have to be used immediately after preparation.

Floor Wax Polish in Paste Form.

To prepare this in the proper way, in quantity, a steam jacketted copper kettle is the best apparatus, and in this the following quantities of material are placed, until finally the whole mass is thoroughly amalgamated and uniform:

20 pounds yellow country pure beeswax	all broken or sliced
8 pounds carnauba wax	
8 pounds paraffine wax	

When the waxes are melted, add 6 ounces of good pure oil soap and 10 Troy grains of fat oil yellow, lemon shade (oil soluble aniline) and 3 ounces synthetic oil of almonds (oil of myrbane); turn off steam and thin, while agitating the mixture with 6½ gallons spirits of turpentine and 3½ gallons heavy naphtha (turpentine substitute). This batch should produce, allowing for some loss by evaporation and shrinkage, 100 lbs. floor wax. Keep agitated and fill into tin cans, while warm, using friction cover cans, pints for one pound size, quarts for 2 pound size, half gallons for 4 pound size and gallons for 8 pounds.

Floor Oils or Floor Dressings.

A floor dressing, that may be used on finished floors to advantage as a polish, when rubbed in well is best made by mixing thoroughly 7½ parts by measure of raw linseed oil, 1¾ parts of pure spirits of turpentine and ¾ parts orange shellac varnish, made with denatured alcohol. Must be always well shaken in the package, before use.

Ordinary floor oils to keep the dust down in warerooms, workshops, etc., are made by heating paraffine

oil, of .885 specific gravity, in a steam jacketted kettle, until it simmers and then add, while agitating, one pound melted paraffine wax, of 130° melting point. This will answer very well as a polish for furniture and bars, as it cleans and polishes in one operation. If a trifle heavy in body, use a little pure turpentine for thinning. To disguise the odor of the paraffine oil, add about 10 drops of oil of myrbane to each gallon.

Furniture Polish and Polish for Cabinet Work.

Dissolve ½ pound orange shellac in one quart of denatured 188° alcohol, then mix with this 3 pounds of raw linseed oil and 2½ pounds spirits of turpentine, then mix ¾ pounds butter of antimony (antimony trichloride) and ¼ pound muriatic (hydrochloric) acid, adding this to the other ingredients, agitating it very thoroughly. It is applied with a soft cloth and will clean and polish at the same time.

Polish for Fine Woodwork.

High polish for fine woodwork is easily prepared. Mix two parts by volume of orange shellac varnish, cut in denatured alcohol and one part of raw linseed oil. This must always be shaken well before using and applied with a soft cloth, that shows no lint, rubbing briskly until hard and glossy.

Furniture Wax Polish in Liquid Form.

Dissolve in a sand or water bath, ¼ pound yellow or white pure beeswax in 2 pounds of raw linseed oil and ¼ pound turpentine. Allow to cool to a temperature of about 80° F., then add ½ pound denatured alcohol orange shellac varnish, stirring the mixture well. Apply with a cloth and rub briskly.

Gold Bronze Paint in Liquid Form.

In preparing this for the trade, for jobbers' or dealers' shelves, the manufacturer must take especial care to select the very finest gold bronze, nothing coarser than that known as No. 6000 will do; also see that the liquid does not contain any turpentine or rosin spirit, as that would tend to green off the bronze very rapidly. A varnish that contains appreciable portions of oil will not serve the purpose, as it will dull the luster of the bronze. A very good formula for gold paint is as follows: Melt hardened rosin in a kettle and pour the melt on a flat pan to cool. When it has become hard, powder it by running through a drug or spice mill or crush in a mortar, then dissolve it, in the cold way, in any hydrocarbon, whose boiling point is below 300°F. Ordinary 62° benzine, that is treated with five per cent. of its weight of caustic lime in powder by agitation and then clarified by filteration has given the best results. Ten pounds of the remelted and powdered hardened rosin to ninety pounds of benzine will make the best liquid for gold paint. Forty pounds fine gold bronze to 100 pounds of the liquid will produce close to 18 gallons liquid gold bronze.

Black Iron Filler for Rough Castings.

This is for use in surfacing castings. Should be used as a priming coat, made thin with benzine and applied with the brush. Then when dry, should be gone over with the paste filler, using wide flexible spatulas, wetting the paste slightly with benzine in order to smooth it down. When dry it is sandpapered and when gone over with some turpentine or benzine, must not show

cracking or parting on drying. In order to obtain best results, the japan in which the pigments are ground for this filler, should consist of the following ingredients:—

95 lbs. kauri brown chips, 15 lbs. hardened rosin, 35 gallons raw linseed oil, 60 lbs. litharge, 10 lbs. fine black oxide of manganese, fused as usual in making japan, until a clear plaster is had, when tested on glass. Take to thinning room and cut out first with 10 gallons turpentine or turpentine substitute and reduce with 50 gallons 62° benzine. Should result in 100 gallons of brown japan. To produce 100 lbs. of filler, place in a chaser or strong mixer 3 gallons of this japan with 64 lbs. mineral black filler and 16 lbs. Paris white.

High Grade Iron Filler and Surfacer, also Steel Color Finish.

This is usually applied on smooth castings, two coats being given. When dry and hard, it may be rubbed with pumice and water, but is mostly smoothed down with emery cloths and oil. The following formula produces a light shade of steel color, but by increasing the percentage of lampblack, a medium or dark shade is obtained. Must be ground fine on suitable mill:

30	lbs.	slate flour (ground slate);
15	"	bolted American Paris white;
15	"	fine silica or pumice;
½	"	dry lampblack;
8½	"	dry white lead;
8½	"	barytes, floated;
20	"	black filler japan;
2½	"	hard rubbing varnish;
100 lbs.		

Ordinary Steel Color Paint in Paste Form.

For a dark steel color, that is to be simply used on iron or steel, either for dipping or for application with the brush, after thinning with benzine or turpentine substitute, the inert material must be buoyant in order to keep in suspension and prices being rather low, the pigment must be selected so as not to require too much of the more expensive vehicle.

For producing 100 lbs. of the paste, the following may be mixed in a chaser without grinding in a mill:—

6 lbs. lithopone, 4 lbs. dry lampblack, 68 lbs. American Paris white, 10 lbs. raw linseed oil and 14 lbs. brown japan of the grade described in the following formula. (Figuring on a total of 102 lbs. of material allows for waste and evaporation in the process of manipulation.)

Ordinary Brown Japan.

Fuse by melting 100 pounds F rosin, 6 gallons raw linseed oil, 15 pounds litharge and 15 pounds fine black oxide of manganese, cut with 7 gallons substitute turpentine and finally thin with 60 gallons of 56° benzine. Result 60 gallons.

Strong Drying Brown Japan.

Make as above, but use 100 pounds F rosin, 20 pounds brown sugar of lead, 10 gallons raw linseed oil, 30 pounds fine black oxide of manganese, cut out with 5 gallons of 90% coal tar benzol and thin finally with 45 gallons of 56° benzine. Result 65 to 67 gallons. This is an excellent drier for moderate priced ready mixed paints containing mineral pigments.

Cheap Gold Size Japan.

Melt 110 pounds hardened rosin and fuse with 9 gallons varnish maker's linseed oil and 44 pounds litharge. Thin with 50 gallons turpentine. Result 67 gallons.

High Grade Grinding Japan.

A reliable japan for use in grinding coach colors, etc., can be made by fusing 55 pounds brown No. 3 kauri gum with 17 gallons V. M. linseed oil, 100 pounds litharge and 20 pounds fine black manganese oxide, until the drying mediums are well amalgamated, when 55 gallons of turpentine is added in the thinning room. The result, when settled clear, will be 72 gallons, weighing 8½ pounds each. This japan dries not merely on top of the film, but right through, and the only drawback is, that it requires settling in a warm storage room for over a month, before it becomes clear enough for use. This is not the case with grinding japans made with gum shellac.

Lacquers for Brass.

An excellent clear spirit lacquer for brass may be made by dissolving, with the aid of gentle heat, in a water bath in a well tinned vessel, that can be closed to avoid evaporation, one pound of gum sandarac, one and one quarter pounds bruised white shellac and one quarter pound gum elemi in four gallons of 188° denatured alcohol. When dissolved, strain off and treat the sediment with more alcohol, then filter through cloth.

Another good formula for clear brass lacquer is to dissolve one pound seed lac, one pound bleached shellac one half pound genuine Venice turpentine in three gallons of denatured alcohol (188° grade).

Colored lacquer for brass can be made by simply dissolving gamboge and dragon's blood separately in alcohol, straining the resulting colored liquids and adding sufficient of each to either of the above clear lacquers to obtain the desired effect.

Lake Boats' Seam Cement White.

This so-called cement or unskrinkable putty is used to quite an extent for what is known on the inland lakes as a material for "paying seams" on wooden craft and is in the form of glaziers' putty. Should be mixed as stiff as possible, then permitted to "sweat" a few days, and finished by giving it a loose run through a mill, or if the batch be large enough, put through a putty chaser. For a batch of 500 pounds mix the following: 250 pounds bolted gilders' whiting, 75 pounds bolted English china clay, 30 pounds dry white lead, 80 pounds pure white lead in oil (keg lead) 50 pounds bodied linseed oil (without drier), 10 pounds pale rosin oil, 5 pounds paint (paraffine) oil.

This is pressed into the seams with flexible putty knives of proper width, after the edges of the seams have been given a coat of seam paint, of the following composition:

Lake Boats' Seam Paint White.

Grind fine the following paste: 44 pounds bolted gilders' whiting, 6 pounds keg lead in oil, 12 pounds bodied linseed oil. On cooling, thin this paste with 18 pounds bodied linseed oil and 22 pounds paint oil (paraffine oil, debloomed). Net result 100 pounds or 8½ gallons liquid paint, weighing close to 11¾ lbs. each.

If these compositions are required in colors, such as buff or red, use ocher for the former with the white and strong red oxide for the latter; for gray or lead color, tint with lamp-black. The cement, when used as outlined, after coating the edges of seams with the paint, will never dry brittle, but retain its toughness and elasticity, and *therefore will not lose its hold.*

Locomotive Finish Black.

For a batch of 50 gallons jet black locomotive enamel grind 13 pounds finest grade carbon black, that has been freed from moisture in a drying oven or kiln, in 12 gallons of a good grade of rubbing varnish through a water cooled mill as fine as possible, and when this soft paste has cooled sufficiently, place it in a liquid paint mixer, beating it with 3 gallons gum spirits of turpentine, then add gradually 35 gallons of long stock kauri varnish and strain through very fine mesh wire sieve or strainer. The rubbing varnish used in grinding may be replaced in part by say 4 gallons of a good coach grinding japan to 8 gallons of rubbing varnish and the latter should be short stock kauri gum of the 8 gallon oil variety while the long stock finishing varnish used for thinning is best for the purpose, when of the 20 gallon oil formula. The former practice of using genuine ivory black or drop black has been pretty well abandoned, because of its settling tendency, no matter how fine it was ground.

Locomotive Enamel Brunswick Green.

Follow the formula for black with the exception, that instead of grinding 13 pounds carbon black, only 9 pounds of the black and 7 pounds of chemically pure

chrome green, medium are ground in 4 gallons coach grinding japan and 8 gallons of rubbing varnish. If any special shade of this green is desired, the proportions of black and green may be changed to suit or the shade of the green changed to light or dark as required.

Locomotive Inside Cab Enamel.

This is usually green and the practice is that chrome green in japan is thinned with turpentine and so applied, drying flat and finished with clear varnish. However, this is not the rule with all roads and when cab enamel is called for it is wanted in ready-for-use form. The light or medium shades of chrome green are preferred and chemically pure green is the best to use for this class of goods to avoid sediment in the package. The following formula will give very good results:

Grind 25 pounds chemically pure chrome green light or medium shade, or a mixture of these shades as may be required, in 2 gallons of coach grinding japan, through a water cooled mill fine as possible and on the last run add one gallon rubbing varnish of not too dark a color. Thin the resulting soft paste, when cooled, with at least three gallons pure gum spirits of turpentine, then add gradually 42 gallons of a good hard drying varnish, that dries of itself within 12 hours. Result 50 gallons.

Marine White Enamel for Yachts.

Grind best French process zinc white in the very palest bodied linseed oil, that may be in the nature of blown oil or lithographers' varnish without drier. The proper proportions are:

60 lbs. dry zinc white, 30 lbs. of the bodied oil and 10 lbs. gum spirits of turpentine. Allow this base to cool, then beat it up in a power mixer (change can) with 2½ gallons turpentine and add 16½ gallons palest kauri gum varnish (wearing body or white enamel varnish, so-called).

If marine enamel of lower price is wanted, grind American selected zinc white in place of the French process zinc, as above, and thin in the same proportion as above, using a good white mixing varnish. The weight per gallon in either case should not exceed 10 pounds in order to make the enamel flow freely.

Marine Eggshell Gloss White.

A white paint of this class is often in demand for yachts and motor boats. The idea is to have as little glare as possible and the paint is expected to last one season only and is expected to wear in such a manner, as to make it easily removable leaving a clean surface for repainting.

Grind a base of 45 pounds American zinc oxide, and 30 pounds magnesium silicate (asbestine) and one pound white sugar of lead in 24 pounds of clarified or refined linseed oil and, on cooling, thin this paste with 4 gallons turnpentine and 2 gallons moderate priced white mixing varnish, producing 10 gallons of paint, weighing 13 pounds per gallon.

This paint applied to the hulls of steel craft, will gradually wear off and leave a surface, that, with very little sandpapering, will be ready to receive new paint, without the necessity of burning off or using paint remover.

When selling price permits, a paint of similar characteristics, but of far better covering capacity can be produced by grinding a base of 40 pounds sublimed white lead and 40 pounds American zinc white with 2 pounds white sugar of lead in 18 pounds refined oil, thinning this soft paste with 2½ gallons turpentine, ½ gallon pale drier and 2 gallons of clarified oil of good body, thus producing 8¾ gallons of paint, weighing 15½ pounds per gallon. The use of varnish in this latter formula is best avoided, as sublimed white lead does not act well with varnish, when the paint is kept in stock for any length of time.

Marine Black for Ship's Hulls

A very good black paint for use on steel ships above the water line is produced by grinding a paste as follows:

10 pounds best gas carbon black, 5 pounds dry red lead, 30 pounds water floated silex or silica, 55 pounds boiled linseed oil. It may be put up in paste form to be thinned by the consumers with linseed oil, dryer and turpentine or may be put up in ready for use form by the following formula. Beat up in a paint mixer 45 pounds of the paste black and add 43 pounds boiled linseed oil, 7 pounds strong liquid dryer and 5 pounds turpentine. Result 100 pounds or 11 gallons paint.

Note. Do not use a japan or liquid dryer, that contains rosin or lime, but let it be a concentrated oil dryer. This black is considered a very high grade material and will give very good service.

Marine Black with Magnetic Oxide

This paint can be put up in paste form after grinding on the following formula: 75 lbs. magnetic black oxide,

precipitated, 1 lb. carbon black, 6 lbs. zinc oxide, 18 lbs. fire boiled linseed oil. The percentage of oil required depends largely on the gravity and fineness of the magnetic oxide. It may also be cheapened for cost by the addition of barytes to the extent of one third the weight of the magnetic oxide without materially increasing the oil required in mixing and grinding. It is not recommended to offer this paint in liquid form.

Marine Black with Asphaltum Base

A good black paint, useful on the hulls of wooden or iron vessels, where long continued wear is not looked for so much as low selling price may be made by mixing carbon black paint with benzine asphaltum varnish. It is necessary, however, that the latter, when tested by itself, should dry to the touch in three or four hours. The black to be mixed with this must be ground in boiled oil and must not be extended with any heavy inert material, such as barytes, etc., nor should it contain any whiting, gypsum or silex. To 8 gallons benzine asphaltum varnish (free from coal tar) add 4 pounds lampblack in oil previously mixed with 12 pounds boiled linseed oil and 2 pounds strong liquid dryer. When well mixed, strain through a sieve or fine paint strainer. Result 10 gallons.

Mortar Colors (Moist in Paste)

There is quite a demand for these by the building trades, but to manipulate this material profitably requires facilities for handling at little cost. Where the output is large, edge runner mills (chasers) are best adapted, but the kneading machines, similar to those

used in bakeries are also quite handy. The colors most in demand are limited to less than half a dozen comprising black, red, brown, buff, and chocolate, very seldom green or blue is desired. Of course the colors must be alkali proof and should be strong, although not brilliant. Usually natural oxides and yellow ochers are selected, while for black mineral black is favored, very seldom vegetable black. The percentage of water in mortar color depends upon the gravity of the pigment and its fineness as well. It is merely necessary to wet up the pigment with water and give it a thorough mixing, so as to form a uniform mass, that will not dry up too readily or permit the water to separate in the package.

Mast Color (also U. S. Navy Spar Color)

This spruce color effect was quite extensively called for before the present modern navy had developed, and it is still a favorite with mariners of the merchant service. When made in paste form, the following composition was in vogue:

64 pounds dry white lead, 16 pounds American zinc, 6 pounds French yellow ocher, 1 pound strong Venetian red, ground in 13 pounds refined linseed oil.

To produce this color in ready for use form, mix 70 lbs. white lead in oil, 20 lbs. zinc white in oil, 8½ lbs. French yellow ocher in oil, 1½ lbs. Venetian red in oil and thin with 5 gallons raw linseed oil and ½ gallon good turpentine japan. Result close to 9 gallons of paint, weighing 16 lbs. per gallon.

For commercial purposes, where there are no specifications to follow and selling price must be low, the addition of a moderate proportion of inert extending

material, would not injure the durability of the paint, although diminishing body and spreading capacity. The paste may then be mixed and ground as follows: 52 pounds dry white lead or sublimed white lead, 13 pounds American zinc oxide, 4¾ pounds dry French yellow ocher, ¾ pounds dry Venetian red, 15 pounds dry asbestine, 14½ pounds raw linseed oil. In ready for use form it would figure out as follows: 70 pounds of the paste, thinned with 26½ pounds raw linseed oil and 3½ pounds liquid drier; will result in 100 pounds or 6⅔ gallons liquid paint, weighing 15 pounds per gallon. The difference in cost per gallon for material between the paint made without extender and that made with extender is 12½ per cent. in favor of the latter, when figuring dry lead at 6½c and zinc at 5½c per pound and linseed oil at 52c per gallon of 7½ pounds.

Paints to Specifications

To design a paint, be it in paste or liquid form, requires a thorough knowledge of the materials, that are to be used; that is, their chemical composition, as most specifications are worded in chemical names and synonyms. For instance, a structural iron paint of dark chocolate brown is wanted in paste form, the specifications calling for a pigment being composed of not less than 23%, nor more than 28% sesquioxide of iron (Fe_2O_3), not over 2% carbon, not less than 2% nor more than 5% carbonate of lime ($CaCO_3$), balance to be inert material, not less opaque than sulphate of lime, to match in color the standard sample submitted, etc., the pigment to be ground fine enough in pure raw, well settled linseed oil to meet certain tests, that are

also described. The pigment portion of the paste to be not less than 73% nor more than 76% by weight and the vehicle not less than 24% nor more than 27% by weight. Then follow the usual rules under which shipments will be rejected. Now in order to meet the specifications it is immaterial, whether the pigment, containing the requisite percentage of sesquioxide of iron is an artificial product or natural or whether it is red, brown or yellow, so long as the color to be matched, can be obtained without the addition of more carbon black or the addition of a pigment, that would increase the percentage of sesquioxide of iron over the limit.

When the paint to this specification was made originally, the author found, that to use sulphate of lime in the form of gypsum made grinding rather difficult and after selecting the proper pigment with the required portion of iron oxide, made use of a fine grade of clay, thus making manipulation in mixer and grinding through the mill more simple, because in this way the color was not materially changed in grinding. Thus the color produced consisted of a native red, averaging 89 per cent. sesquioxide of iron, the carbon black specified, balance of pigment being china clay, or in detail as follows:

1½ pounds carbon black, 3 pounds whiting, 22 pounds native red as above and 47½ pounds china clay or a total of 74 pounds dry pigment and 26 pounds of raw linseed oil.

It will be noticed, that for instance a burnt ocher of from 28% to 30% sesquioxide of iron would have served the purpose equally as well and made the addition of china clay unnecessary. Yet the cost of a burnt ocher of that strength or a native red ocher would be higher,

than the cost of china clay and the texture of the ocher would not be equal in fineness to that of the clay. All of these points must be considered to make it possible to meet competition as well as the chemists' specifications.

Another structural iron paint, where the specifications read as follows: The pigment of which this paint is to be composed must consist solely of 60% sesquioxide of iron, Fe_2O_3, 23% silica, SiO_2, 5% red lead, Pb_3O_4 5% white lead, $PbCO_3$, 5% zinc oxide, ZnO, and 2% zinc chromate, $ZnCrO_4$. The vehicle must consist of well settled, pure raw linseed oil and not over 10% drier, and the volatile matter must not exceed 4%.

The pigment must be 55% and the vehicle 45%, with a permissible variation of not over 2% either way.

Considering these specifications not from the chemical, but from the practical standpoint, it is difficult to see, what function the white lead and zinc chromate exercise in this paint, when it is to be used over old painted surface and not on the bare metal, as was the case here. But leaving this aside, the items of 60% sesquioxide of iron and 23% silica would indicate, that a silicate of iron is wanted, yet this is rather difficult to obtain in a red, such as the desired color must be. Judging from the prices, at which proposals for this paint are awarded, the red pigment cannot possibly be a chemically pure oxide of iron and as the lower priced grades or native reds always contain more or less alumina in addition to silica, the specifications cannot be strictly adhered to by the successful bidders. To all appearances, then it may be assumed, that the nearest approach is a paint made about as follows: 38½ lbs. native red of 87% Fe_2O_3, 7⅛ lbs. silica, 2¾ lbs. dry red

lead, $2\frac{3}{4}$ lbs. dry white lead, $2\frac{3}{4}$ lbs. zinc oxide, $1\frac{1}{8}$ lb. zinc yellow, 40 lbs. raw linseed oil and 5 lbs. strong drier. Weight about $12\frac{1}{2}$ lbs. per gallon.

Megilp for Artists.

This should be in every assortment of artists' tube colors, it being used by them as a drying medium. It is prepared as follows in quantity:

Heat in an enameled kettle 12 pounds raw linseed oil with 10 ounces of fine litharge for 30 minutes, stirring with a glass rod all the time, then set aside to cool and settle. After 24 hours decant the oil off the sediment and filter it. Also melt on a water bath 4 pounds gum mastic in 8 pounds gum spirits of turpentine and when the gum is dissolved, set the kettle away over night, then filter the solution and stir it into the oil. When thus well mixed, set the material in a cold place, during the winter time, and in summer keep in a refrigerator. Fill tubes only, when called for.

Gumption (Drier) for Artists.

Mix well together, one volume concentrated solution of white sugar of lead, two volumes bleached linseed oil and two volumes of gum mastic, dissolved in turpentine.

Paint Remover at Low Cost.

When surface is to be repainted and the discoloration of wood not considered, as on barns or other rough work, a cheap remover may be made as follows: Dissolve 7 pounds of 98% caustic soda in 2 gallons of water and allow to cool. Wet up one pound each of ordinary corn-

starch and china clay with water and reduce the resulting paste until 2 gallons of water have been added to the dry starch and clay. Add the latter to the caustic soda solution, when a smooth paste will result. Apply liberally to the paint and when the old coating has lifted, scrape off with a light touch and wash with clear water. This paste will also remove wall paper or varnish.

Paste Drier for Printing Ink Plate Printing.

This material should be made up in an edge runner mill (chaser) in the form of a medium stiff paste and in order to be successful, the pigments must be of utmost fineness and entirely free from grit. The white lead in oil must be ground stiff in refined or bleached linseed oil at the rate of 8 pounds of oil to 92 pounds pure white lead (basic carbonate), and the materials must be put into the chaser in the order given here. For a batch of 500 pounds, allowing for a few pounds of waste, place in the chaser gradually

240 lbs. natural white barytes, water floated;
120 " bolted English Cliffstone, whiting;
60 " pure white lead, stiff ground in oil;
45 " pale boiled linseed oil and
40 " special solution, as per formula below.

Note. Mix the linseed oil and solution before adding it slowly to the pigments.

Special Solution for Above Paste Drier.

Dissolve, in 5 gallons hot water, 40 pounds anhydrous white sugar of lead, also $5\frac{1}{2}$ pounds chemically pure sulphate of manganese (in crystals) in $1\frac{1}{2}$ gallons hot

water. When solutions are complete, add the two together and strain through cheese cloth to remove any fibre, lint or other undissolved matter. Result 100 pounds. This solution will also serve for a

Paste Drier, Without White Lead, for Paint.

For an excellent material, where liquid driers are undesirable, and for a batch of 500 lbs. the following ingredients are used:

250	pounds	best bolted American Paris white,
125	"	fine white barytes,
75	"	siccatized linseed oil,
50	"	special solution as above.

Note. The siccatized linseed oil is made in the cold way in a revolving barrel or drum as follows:

For 25 gallons placed in the apparatus, add 50 pounds sifted litharge and let it revolve by power for 8 working hours, then draw the resulting oil into a settling barrel or tank and permit the oil to clear. The residue, which consists of litharge and oil foots can be used with cheap roof paints.

Manganese and Lead Paste Drier.

A paste drier used by manufacturers of printers' and lithographers' inks in the consistency of fairly stiff putty is produced by pulverizing fine 32 pounds anhydrous white sugar of lead and 8 pounds fused resinate of manganese in 8 gallons of double boiled manganese oil to impalpable fineness. May be ground on a good stone mill with large eye and finished smooth on roller mill.

Paste Drier Without Manganese.

This is useful for mixing with white oil paint, where the pink cast given by manganese salts is to be avoided, as for inside work: Mix 7 pounds dried zinc sulphate, 3½ pounds fine litharge, 2 lbs. white sugar of lead in 2½ pounds pale boiled oil and grind fine as possible. Then mix 20 pounds dry white lead and 50 pounds bolted Paris white with 15 pounds pale boiled oil, grind and on the last run through mill, add the 15 pounds of driers, first ground to make 100 pounds of soft paste drier.

Paste Drier for Zinc White or Lithopone.

Guynemer's Drier, that at one time was quite a favorite for drying zinc, especially for flat inside work is now practically obsolete, even in Europe. It was ground with too much zinc oxide to exhibit great drying strength. Zumatic Drier also is not a good drier for the purpose as manganese borate, which was a component part of the material, has the bad fault of making inside walls dry out pinkish, when coated with white, in which it is used.

15 lbs. resinate of zinc, powdered;
10 " sulphate of zinc, well dried;
50 " zinc oxide, American;
25 " refined or bleached linseed oil;

are ground very fine and put up in suitable containers. One pound of this drier will dry from 25 to 50 lbs. of zinc white or lithopone paste paint, thinned for flatting with turpentine.

Resinate of Zinc Drier.

Resinate of zinc, when precipitated and packed in casks is very apt to be subject to spontaneous combus-

tion and to make a paste drier with zinc resinate alone, it is best to use fused zinc resinate, dissolving 10 pounds in 10 gallons of varnish makers' linseed oil and in the resulting drying liquid grind dry zinc oxide at the rate of 25 pounds of the oil to 75 pounds zinc, producing a rather soft paste.

Primer for Galvanized Iron.

Grind a soft base as follows:

48	pounds	lithopone of normal composition;
20	"	pure graphite of 85% carbon;
4	"	Indian red of 95% oxide iron;
12	"	bodied linseed oil;
16	"	color grinders' (hard gum) japan;
100 lbs.		

Thin this paste, when sufficiently cooled, with 2 gallons hard gum rubbing varnish and 2 gallons pure spirits of turpentine. Result:—9 gallons of dove gray paint, weighing 14 pounds per gallon, that will permit any good paint applied over it to adhere to the metal indefinitely.

Paint for Metal, (Tin or Iron.)

High Grade Red for Roofs, Sheathing, etc.

Grind a soft paste as follows:

50	pounds	native red, powdered (88% Fe_2O_3);
23	"	magnesium silicate (asbestine);
27	"	raw linseed oil;
100 lbs.		

Thin with 6 gallons raw linseed oil, 1 gallon brown japan or oil and turps drier, resulting in a batch of 13 gallons of red paint of fairly bright color, weighing close to 12 pounds per gallon.

Note. The 73 pounds of native red oxide and asbestine may be replaced with any good red oxide, containing anywhere from 30 to 40 per cent. of sesquioxide of iron.

Red Graphite Paint (Paste).

Red graphite, if so found in nature, is simply a mixture of graphite and red clay and therefore not as good a pigment, as the mixtures sold in practise to consumers, who specify the material for use on structural iron. A good durable paint of that name is prepared as follows:

Paste. 46 pounds natural graphite (85% carbon);
23 " native red (about 88% Fe_2O_3);
31 " double boiled linseed oil;

100 pounds mixed and ground fine.

Red Graphite Paint (Liquid Form, ready for Use.)

Thin 100 pounds of above paste with 10 gallons double boiled linseed oil and 2 gallons strong brown japan, resulting in 19 gallons of paint, weighing fully 10 pounds per gallon, covering well in one coat.

Roof Stopping (for leaky tin roofs).

Place into a change can mixer, 19 pounds rosin oil (first run will do), 3 pounds pine tar (free of water), 30 pounds cheap Venetian red, 24 pounds ground slate (slate flour) and 24 pounds common whiting; mix well,

adding a few ounces finely chopped fibre or cow's hair. Put up in paste form and sold by weight. Pressed into leaks with flexible putty knives.

Red Mineral Primer Paste for Engine Tenders.

One of the largest concerns building locomotives use for priming the bodies of tenders a dull red in paste form, which they thin with substitute turps. Can be made by mixing and grinding 55 pounds native red oxide (of not less than 75% Fe_2O_3), 25 pounds ground slate (slate flour) in 10 pounds raw linseed oil and 10 pounds cheap brown japan.

Rivet Head and Butt End Cement for Steel Vessels.

The following composition has been in use for many years by one of the largest ship building companies in the United States:

Paste for Trowelling and Knifing in:

Mix and grind to a medium stiff paste the following:

50	lbs.	dry basic carbonate of lead;
12½	"	bolted American Paris white;
15	"	pure Indian red, deep shade (95% Fe_2O_3);
10	"	hard gum coach japan;
12½	"	hard gum rubbing varnish;
100 lbs.		

The same cement for Flowing:

92 pounds of the paste cement (4 gallons) thinned with one half gallon spar varnish of fair grade and one gallon of turpentine will produce 5½ gallons of what is known as marine cement for flowing, weighing 18½ pounds per gallon.

Roof Paint Elastic Black (Cheap).

In a portable iron kettle, of 100 gallons capacity, melt 150 pounds black rosin and 150 lbs. tar pitch together, then add 15 gallons of tar oil (heavy naphtha) and when this is well in, take kettle from fire (or if kettle is not portable, draw fire) and add 25 gallons of thin benzine asphaltum varnish, stirring the mixture well, while kettle is still hot. If on cooling, the black paint is too stout to spread readily under the brush, thin with benzine or still better, with solvent naphtha. The formula, as above given, should produce not less than 67 gallons of paint, making allowance for waste.

Ship Paints, (as sold by ship chandlers).

These are in paste form furnished in various sizes and styles of packages. The grinding is usually done in a careless way, but more often the goods are simply put through a mixer, and very frequently it may be discovered, that the pigments are not mixed with pure linseed oil, but in a linseed oil emulsion, carrying as much as 33% water. The following formulas, while not prohibitive for cost, are based on pure linseed oil as vehicle.

Boot Topping for Ships.

100	pounds	basic lead sulphate (sublimed lead);
25	"	American zinc oxide;
25	"	whiting, common;
25	"	Indian red, deep (American);
275	"	natural barytes, ordinary fine;
50	"	raw linseed oil;
500	pounds	finished product.

If the Indian red is in fine division, a very thorough mixing will make this paste smooth enough and thus obviate the necessity for grinding in a mill. The sublimed lead may be replaced by basic lead carbonate (white lead).

Black Marine Paint.

40	pounds	ordinary lampblack, dry ;
360	"	" barytes;
100	"	boiled linseed oil;
500	pounds	paste.

Jet Black Marine Paint.

15	pounds	gas carbon black, dry;
25	"	clay (kaolin);
360	"	ordinary barytes;
100	"	boiled linseed oil;
500	pounds	paste.

Note. First grind carbon black and clay in 75 pounds of the oil. When done, place in a change can mixer, add balance of oil and the barytes.

Marine Blue Paint.

15	pounds	Prussian blue, dry;
35	"	English china clay;
385	"	ordinary barytes;
65	"	raw linseed oil;
500	pounds	paste.

Note. First grind the Prussian blue and clay in 35 lbs. of the oil, place the resulting blue in change can mixer, add balance of oil and the barytes.

Bronze Green Marine Paint.

20	pounds	chemically pure chrome green, dark shade;
10	"	burnt Turkey umber, powdered;
10	"	chemically pure chrome yellow, lemon shade;
395	"	ordinary barytes;
65	"	raw linseed oil;
500	pounds	paste.

Note. Grind the first three items in 25 pounds of the oil, place in change can mixer and add balance.

Burnt Turkey Umber Marine Paint.

200	pounds	burnt Turkey umber in oil;
280	"	ordinary barytes;
20	"	raw linseed oil;
500	pounds	paste.

Note. Use change can mixer for above.

Chocolate Color Marine Paint.

150	pounds	purple oxide of iron (powdered);
25	"	American zinc;
25	"	asbestine powder;
235	"	ordinary barytes;
65	"	raw linseed oil;
500	pounds	paste.

Note. Grind the first three items in 45 pounds of the oil through a mill and add balance in the change can mixer.

Oxide of Iron Red Marine Paint.

125	pounds	Persian Gulf red (powdered);
25	"	asbestine powder;
280	"	ordinary barytes;
70	"	raw linseed oil;
500	pounds	paste.

Note. Grind the first two items in 45 pounds of the oil on a buhr stone mill and add balance in change can mixer.

Marine Green Paint, any shade.

65	pounds	chemically pure chrome green in oil;
35	"	china clay, fine bolted, dry;
350	"	ordinary barytes, dry;
50	"	raw linseed oil;
500	pounds	paste.

Note. This formula is for a medium shade and when given time to mix thoroughly in a change can mixer, will produce a smooth paste. For the dark green, the proportion of oil must be slightly increased, while for the light shade, it may be somewhat decreased.

Marine Grey Paint.

200	pounds	red seal lithopone, dry;
2	"	Prussian blue in oil;
3	"	lampblack in oil;
245	"	fine white barytes;
50	"	raw linseed oil;
500	pounds	paste.

Note. This can be made in any power mixer, as grinding in mill is not required. May be made in an edge runner mill (chaser), but it is not economical to discolor the apparatus by the shading material.

Mast Color Paint.

100	pounds	sublimed white lead (or basic lead carbonate);
25	"	American zinc oxide;
25	"	whiting, bolted;
7	"	medium chrome yellow in oil;
3	"	Venetian red, medium in oil;
285	"	fine barytes;
55	"	raw linseed oil;
500	pounds	paste.

Note. A thorough mixing is all that is required to produce a smooth paste, if the white ingredients are free from grit.

Teak Color Paint.

150	pounds	red seal lithopone, dry;
30	"	mineral brown (purple tone);
5	"	French yellow ocher;
5	"	Venetian red, medium;
250	"	ordinary barytes;
60	"	raw linseed oil;
500	pounds	paste.

Note. It is most economical to grind the first four items in 35 pounds of the oil and add balance in change can mixer.

Venetian Red Marine Paint.

100	pounds	Venetian red, medium (30% Fe_2O_3) in oil;
365	"	ordinary barytes;
35	"	raw linseed oil;
500	pounds	paste.

Note. Mix thoroughly in change can mixer. Most so-called Venetian reds for this trade contain only one-half of the weight of color referred to above and twice the weight of barytes.

White Lead Marine Paint.

This is rarely ever made up for marine trade to be sold by ship chandlers, but we will make note of a few formulas that have been used:

200	pounds	dry white lead (basic carbonate);
250	"	fine white barytes;
50	"	refined linseed oil;
500	pounds	paste.

Ground in stone mills of large diameter. Another brand was composed of:

100	pounds	dry white lead (basic carbonate);
100	"	sublimed white lead (basic sulphate);
250	"	white barytes;
50	"	refined oil;
500	pounds	paste.

Ground as above.

Zinc White Marine Paints.

The best selling brand of this character known to the author, was made as follows:

225	pounds	extra selected American zinc oxide;
225	"	Missouri floated barytes;
50	"	refined linseed oil;
500	pounds	paste.

Note. In order to manipulate this with such a small percentage of oil, it was necessary to give the material a good chasing under a powerful wheel.

Combination Marine White Paste.

160	pounds	dry white lead (basic carbonate);
65	"	American zinc oxide XX;
225	"	fine white barytes;
50	"	raw linseed oil;
500	pounds	paste.

Note. The above is best manipulated in chaser and smoothed by running over granite rollers.

Non-Darkening White Deck Paint.

The following paint is not affected by sulphur gases, sometimes prevailing on steamer decks:

35	pounds	sublimed white lead (basic lead sulphate);
35	"	American zinc oxide XX;
10	"	floated barytes, extra fine;
5	"	magnesium silicate (asbestine);
15	"	refined or bleached oil;
100	pounds	paste.

To make this in form ready for use:

Mix thoroughly:

82	pounds	of above paste;
3½	"	spirit of turpentine;
4	"	pale bodied linseed oil;
3¾	"	pale drying japan;
6¾	"	refined oil;
100	pounds.	

Result 6½ gallons paint, weighing 15 lbs. 6 oz. per gallon.

Slushing Compound for Castings.

A cheap liquid paint for keeping iron castings from rusting, while stored exposed to the elements.

30	pounds	mineral brown or red;
30	"	common whiting;
24	"	paraffine (paint) oil;
4	"	cheap liquid drier;
14	"	benzine;
100	pounds=7½ gallons.	

Note. Mix mineral brown or red, and whiting, in the oil until a smooth semi-paste results, then add the drier and the benzine. This slushing compound is used only to coat the castings until they are made use of, when the slushing is easily removed with hot soda solution or benzine.

Ship's Bunker and Hold Paint, Liquid.

Quick Drying Red.

Mix and grind a paste as follows:

50	pounds	Indian red, pale (95% Fe_2O_3);
10	"	American zinc oxide;
10	"	fine barytes;
10	"	bolted whiting;
20	"	boiled linseed oil;
100	pounds soft paste.	

Thin 100 pounds of the paste with one-half gallon brown japan and 6 gallons of thin mixing varnish, producing 10 gallons of paint ready for use.

Ship's Hold Paint White, Liquid.

(Quick Drying).

Mix and grind a paste as follows:

68	pounds	red seal lithopone (standard quality);
17	"	bolted American Paris white;
15	"	pale boiled oil (heavy body);
100	pounds	paste.

Thin this paste with 5 gallons pale mixing varnish of China wood oil composition, that will dry of itself in from six to eight hours. Result 10 gallons of ready for use paint, weighing 13¾ pounds per gallon.

Silicate Paint.

When silicate paints are called for, it does not follow that they are to contain silicate of soda or potash (water glass), but that a certain portion of the dry pigment is to consist of silica or silex. Sometimes they are termed silicated paints and, unless otherwise designated, oil paints are referred to. Silicate paints are usually, when called for in white, based on zinc oxide or lithopone for the covering principle and here are a few specimen formulas for paste goods.

White Silicate Paint, Paste.

200	pounds	red seal lithopone (30% ZnS);
200	"	finest floated silica (pure white);
25	"	bolted American Paris white;
75	"	refined or bleached linseed oil;
500	pounds	paste.

Note. This is best manipulated in a chaser and smoothed by running over granite rollers.

Green Silicate Paint, Paste.

Mix in a power mixer (change can preferably);

85	pounds	chemically pure chrome green light, ground in linseed oil;
180	"	fine barytes;
180	"	finest floated silica or silex;
55	"	raw linseed oil;
500	pounds	paste.

Note. If given time to mix thoroughly, it will not be necessary to run through a mill, otherwise a loose run will be required to produce a smooth paste.

Silicate of Soda Paints.

The liquid for these compounds is best prepared as follows: Mix 100 pounds of silicate of soda of 40° Beaume and 12 gallons water; boil the mixture and while boiling, sift coarse powdered rosin to the amount of 25 pounds into the kettle, stirring until the rosin is dissolved, then strain through cheesecloth. Use pale rosin, so as not to discolor white or light tints. The above will yield 20 gallons liquid, which can be used alone with lime proof pigments or may be mixed with an equal volume of raw or boiled linseed oil to produce a washable paint. In giving the following formulas for paints of the latter type, we shall refer to the vehicle as mixed thinners, meaning a mixture of equal quantities by measure of the liquid and raw linseed oil. The most convenient form to offer these paints in is a semi-paste, so that the consumers may thin it for use with either water or oil.

White for Exterior Use.

20	pounds	American zinc white;
15	"	bolted American Paris white;
30	"	asbestine powder;
35	"	mixed thinners;
100	pounds	semi-paste=7 gallons.

White for Interior Use.

20	pounds	red seal lithopone;
10	"	bolted American Paris white;
35	"	asbestine powder;
35	"	mixed thinners;
100	pounds	semi-paste=6¾ gallons.

These whites may be tinted with colors ground in oil, with the exception of Prussian or Chinese blue and chrome greens.

Solid washable paints, may also be prepared with the mixed thinners referred to, and we shall confine ourselves to giving a few specimen formulas.

Washable Water Paint Black.

25	pounds	mineral black;
25	"	asbestine powder;
50	"	mixed thinners;
100	pounds	semi-paste=8 gallons.

For use, this should be reduced with equal portions of linseed oil and water.

Washable Water Paint Blue.

10	pounds	ultramarine blue (lime proof);
15	"	bolted American Paris white;
35	"	asbestine powder;
40	"	mixed thinners;
100	pounds	semi-paste=7 gallons.

Washable Water Paint Yellow.

30	pounds	French yellow ochre;
25	"	asbestine powder;
45	"	mixed thinners;
100	pounds	semi-paste=8 gallons.

Washable Water Paint, Red.

20	pounds	Venetian red, medium shade;
10	"	bolted American Paris white;
30	"	asbestine powder;
40	"	mixed thinners;
100	pounds	semi-paste=7 gallons.

Washable Water Paint Green.

15	pounds	lime proof green (of desired shade);
40	"	asbestine powder;
45	"	mixed thinners;
100	pounds	semi-paste=7½ gallons.

Note. These semi-pastes will usually stand gallon for gallon of water, when applied to rough surfaces, such as stone, brick or undressed lumber, but on surfaces like smooth plastered walls or dressed wood, it will not permit as much thinning. It also requires exposure to the air for a week or so, before the painted surface will permit washing.

Silicate Enamels for Metal.

White for imitating enameled ware.

Mix 30	pounds	French zinc oxide;
30	"	dry blanc fixe;
25	"	clear water;
20	"	silicate of soda, 40° Beaume;
105	pounds.	

Run the zinc, blanc fixe and water through a mill to make a fine pulp, then mix the silicate of soda with the pulp and strain through a fine sieve. The result should be 100 pounds of liquid paint, equal to 8 gallons. Should be blued with a little ultramarine blue ground in water, and when two coats have been applied to sheet iron, steel, etc., and each coat baked at 180° F., the effect will resemble porcelain enamel.

A similar effect may be obtained, if the French zinc oxide and blanc fixe is replaced by a similar weight of best grade lithopone white, which will slightly decrease the cost.

Tinted Silicate Enamels.

Add to either of the whites, of the description just given, the necessary coloring matter in pulp form, but use only colors, that are alkali proof.

Tallow and Zinc Composition.

Although the practice appears to have become somewhat obsolete, some mariners may still call for this paint, that found favor up to recent years for the coating of the bottoms and rudders of iron or steel ships. Some of the manufacturers of marine specialties prepared a zinc soap, grinding zinc oxide in this and mixing

the resulting paint with tallow, but it is useless to go to the trouble of preparing the soap. A composition made on the following plan will give equal, if not better, results.

Mix and grind the following paste:

64	pounds	American zinc oxide;
16	"	American Paris white;
20	"	manganese boiled oil;
100	pounds	medium soft paste.

Have some boiled tallow on hand, of the quality used for engines, and warm it somewhat, then mix 50 pounds of the above paste with 4 gallons of pale mixing varnish and 20 pounds of the boiled tallow. This should produce 8 gallons of composition. The pale mixing varnish referred to need not be necessarily of extra high quality, but must not pudding up the paint. A small portion of varnish foots with the varnish will do no harm in this preparation.

Trunk Paints.

Some years since the base of trunk paints was pure white lead in the lighter colors, but at the present time, this material is mostly sold at ruinous prices and its make-up is almost on a par with barrel paints. Yet there are still some makers of trunks, who although buying cheaper material, than their predecessors did years ago, prefer fair quality goods at moderate prices, to the very poor grades very often offered. There are two kinds used, one to dry flat to permit varnishing over, while some are wanted to dry with gloss over a priming of glue size. To make a flat drying trunk paint in buff color mix and grind:

15	pounds	red seal lithopone;
50	"	gilder's bolted whiting;
15	"	yellow ochre;
20	"	boiled linseed oil;
10	"	gloss oil;
100	pounds	paste.

Thin with 2 gallons benzine. Result 8½ gallons.

For an olive green trunk paint, also flat drying, mix and grind:

20	pounds	yellow ochre;
2	"	C. P. chrome green, medium;
1	"	lampblack, dry;
5	"	American zinc oxide;
10	"	asbestine powder;
35	"	gilder's bolted whiting;
13	"	boiled linseed oil;
14	"	gloss oil;
100	pounds	paste.

Thin with 3 gallons benzine. Result 10½ gallons.

When part of the gloss oil in the pastes can be replaced by varnish foots, it will make the paints dry more quickly and insure hardness, but the varnish foots must be fairly liquid and not consist of hard sediment only.

To make trunk paints dry with gloss finish, use the same paste as above. However, do not thin with benzine, but instead reduce it with a quick drying mixing varnish of fair toughness and elasticity.

Note. The trunk paints here referred to are for the canvas covered traveling trunks, and as there are a good many different colors, it is hardly necessary to describe

formulas at length, because every large trunk factory has its own standards, that require to be matched. It is not necessary to use imported oxides, ochers, siennas and umbers in this class of paint, unless the trunk manufacturer is willing to pay for high class goods.

Miscellaneous Paints for Iron or Steel.

First Coat Black for Baking.

Mix and grind fine:

12	pounds	best carbon black;
40	"	blown bodied linseed oil;
16	"	hard gum japan;
32	"	turpentine or turps substitute;
100	pounds	soft paste.

For application with spraying machine or for dipping, thin the paste with 100 lbs. turpentine or 50 lbs. each turpentine and turpentine substitute, producing 200 pounds liquid black or 25 gallons, weighing 8 pounds per gallon. Bake for 2 or 3 hours at 250 to 300° F.

Second Coat Black or Gloss Finish for Baking.

The first coat will dry nearly flat on baking and a finish with high gloss is given as a rule.

Mix and grind fine:

5	pounds	best grade carbon black;
15	"	heavy bodied boiled linseed oil;
40	"	medium heavy hard gum baking varnish;

Let set until cooled and add to the 60 pounds of soft paste, 40 pounds turpentine asphaltum varnish of high grade, not of too heavy body. This batch should pro-

duce 12 gallons of enamel, unless too much is lost by evaporation in grinding. If the paste is ground in a good water cooled mill, the result from a mixing of 60 pounds should be not less than 58 pounds and the 2 pounds of volatile thinner lost, should be added as turpentine when the paste is being thinned.

Flat Black (Air Drying) for Smooth Iron or Steel.

Mix thoroughly and strain through fine mesh:

30 pounds drop black, ground in japan;
35 " black asphaltum varnish, "B";
35 " gum spirits of turpentine;

100 pounds=12 gallons.

The drop black does not require to be of the highest grade, but should be ground fine. This black is not so well adapted for dipping, as it is for application with an ordinary flat varnish brush or a spraying brush.

Flat Black (for Spraying on Planished Metal.)

Mix and grind fine as possible on water cooled mill:

4 pounds finest jet carbon gas black;
12 " bodied drying linseed oil;
20 " color grinders' japan;

36 pounds.

Add enough good rubbing varnish to the above to make 40 pounds of material, which thin with 4 gallons gum spirits of turpentine and 5 gallons good turpentine substitute. Result 13½ gallons. If selling price permits doing so, omit the substitute turps and use 9 gallons gum spirits.

Non-Corrosive or Rust Preventative Black Paint for Steel Freight Cars or Coal Cars.

Since research in paint problems has developed the fact, that sublimed blue lead acts as a rust-inhibitive in paint for iron and steel surfaces, and since it has become a practice to bake priming coats as well as finishing coats on the metal parts of automobile bodies and even on steel cars, it will prove interesting to note, what can be done along this line. Naturally it would hardly seem practical or economical to employ a pigment like sublimed blue lead on the pressed steel of which ordinary coal cars are composed and yet, after giving the subject serious consideration, it may be found to be worthy of extensive trial. The first or priming coat would be nearly dead flat and when baked on the metal at moderate temperature, say 150 degrees, it would also be practically non-abrasive, and on account of its superior spreading properties, the paint the author has in view would not be out of reach on account of price.

Priming Coat for Steel Freight Equipment, etc.

Paste: Mix and grind without overheating:

50	pounds	sublimed blue lead;
5	"	American zinc oxide;
3	"	gas carbon black;
8	"	bodied linseed oil (without drier);
4	"	hard gum japan drier;
8	"	heavy petroleum naphtha;
78	pounds	soft paste.

If the paint is to be used for air drying, it is best to thin the paste with enough pure turpentine to make 100 pounds. If for baking, it may be thinned with turps substitute. In either case the batch should make 7 gallons of paint, ready for application, after a thorough stirring. This primer will air dry inside of 4 hours and readily bake hard enough in 2 hours to admit of a second or finishing coat, which can be of the type usually specified by the various railroad corporations.

Steel Car Black Finish for Baking or Forced Air Drying.

Mix and grind fine a paste, consisting of:

12	pounds	gas carbon black;
25	"	pure floated silica;
13	"	dry asbestine powder;
50	"	raw, well clarified linseed oil;
100	pounds	soft paste.

Reduce this paste with 8 pounds oil japan, 4 pounds turpentine and a mixture of 16 pounds bodied linseed oil and 72 pounds kettle boiled oil. This will produce 21 gallons of paint, that is jet black and dries with good gloss by air or baking. Nor is its cost prohibitive and the selling proposition need not stand in the way, where good and lasting results are actually and honestly looked for by the purchaser.

Surfacers and Enamels for Steel Passenger Car Painting.

It is at once a difficult and thankless task to give recipes or formulas for this class of work, because of the fact, that most every railroad company, whose equipment consists of steel passenger and baggage and mail

coaches have their own standards, that must be matched. Take for instance, the Pennsylvania Railroad Tuscan red, that is supplied in paste form, ground in raw linseed oil and turpentine to specifications. If a color grinder were to furnish this color as a ready to use enamel, he would hardly ever succeed in producing two batches uniform in color effect after application. This is why the painters of that road still make use of the method in practice for years, even if they do bake every coat, that is, they reduce so much paste with so much coach japan, rubbing varnish and turpentine. Were they to add more varnish at one time than another, the color would show quite a different effect. And the same applies to such a one as Pullman color to a still greater degree, although this color can be ground directly in varnish, that would serve well for baking. Still there are no two Pullman coach colors in japan, as received from various shops, precisely alike. Therefore in matching a Pullman color, which may be termed a composite color, in ready for use form as an exterior gloss or enamel finish, the pigments must be ground in clear baking varnish, if the finish is to be baked.

Types of Pullman Coach Body Color Ground in Coach Japan.

40	pounds	French yellow ocher, dry;
10	"	orange chrome yellow, dry;
14	"	drop black, powdered;
1	"	gas carbon black;
32	"	color grinders' japan;
3	"	rubbing varnish;
100	pounds,	

Ground on water cooled mill, until fine, then placed in a mixer, where the necessary shading color is added in fine paste form to produce exact shade of standard, when thinned with turpentine and varnished over.

This is used on the passenger cars of a prominent Southern railroad, both on the bodies, trucks and platforms.

Another shade of *Pullman Car Body Color* in *Japan* with much better covering qualities and richer effect is produced as follows:

30	pounds	ivory drop black, dry;
10	"	medium chrome yellow, dry;
8	"	orange chrome yellow, dry;
4	"	indian red, deep, dry;
3	"	alizarine red lake, dry;
45	"	color grinders' japan;
100	pounds.	

Ground on water cooled mill until fine, and on last run add one-half gallon good rubbing varnish to give a buttery consistence to the paste.

Note. The practical color grinder will admit, that colors of this composition will give varying results, if used as color and varnish coats, according to the percentage of varnish used and the nature thereof.

Joint Compound for Steel Cars for Subway or Tunnel Service.

This should be almost similar to the Rivet Head or Butt End composition for steel ships, and applied when the sheets are joined.

Must be in the form or consistency of medium stiff putty and the following makes the best composition, which should be run through a water cooled mill with large eye; taking good care not to overheat the material:

60	pounds	basic carbonate of lead, dry;
10	"	red lead;
10	"	fine bolted whiting;
15	"	rubbing varnish of high grade;
5	"	raw linseed oil;
100	pounds.	

A thin coating of this compound is applied, when the sheets are rivetted together, the excess being pressed out during the operation, and collected for future use.

Brown Zinc in Paste Form as Specified by the U. S. Navy Department.

This is really a misnomer, as there never was such a pigment known to the trade. A one time student of applied chemistry, long since deceased, suggested this formula to some one in authority and it has been among the United States Navy Department specifications for some 22 years as follows:

40% zinc oxide;
5% red lead;
and not less than 20% sesquioxide of iron.

Balance to be composed of the gangue occurring with oxide of iron in nature. Must not contain lime in any form. In other words it may consist in the pigment portion of 40 parts by weight of American zinc oxide, 5 parts dry red lead and 55 parts of mineral brown, such

as will give the shade desired by the service. Usual proportion of pigment in the paste 78 to 80%, raw linseed oil 20 to 22%.

Waterproof Compositions for Fishing Rods and Baiting Articles of Wood.

Primer for Dipping the Bare Wooden Objects.

Dissolve waste chips or cuttings of celluloid that are free of coloring matter in amylacetate, at the rate of one pound of the chips to three gallons of the solvent.

This will keep the wooden objects from splitting when immersed in water, as the latter will not soak into the wood.

If the objects, such as high priced fishing rods are to be finished in the natural, at least two dippings in the above are required.

Note. This liquid cannot be used for brushing, as the second coat is liable to raise the first.

Waterproof Enamel for Wooden Fishing Baits.

Make a heavy bodied celluloid lacquer by dissolving 2 pounds gun cotton in 10 pounds commercial acetone and 20 pounds amylacetate. Add to this amount one-half pound castor oil to make it flexible. For a white enamel, to be applied by dipping to fishing baits, over the priming above referred to, grind best French process zinc in white damar varnish, 68 parts dry zinc to 32 parts damar varnish, and for every 4 pounds of white paste, use one gallon of the celluloid lacquer. If this does not drip freely, reduce slightly with more amylacetate. This white enamel may be tinted with colors

ground in varnish, but oil colors must be avoided. This enamel may be made more impervious to water and show a far better finish by being dipped into a final coating of **Transparent Waterproof Finish** which is made by pulverizing best selected 5X Kauri gum, dissolving 2 pounds of this in 5½ pounds, allowing it to clear by settling and final filtering.

Waterproofing Compound for Export Canvas Covered Packages.

Very flexible and durable compositions are made in various colors by grinding chemically pure pigments of great color strength in castor oil to fairly stiff paste form, which are let down with celluloid varnish for use on canvas covered packages. These are mostly used for the transportation of powder and other explosives, the color denoting contents of the packages to the initiated. It has been ascertained, that when gun cotton in solution with amylacetate has a certain small percentage of castor oil added, the resulting film, when dry shows a toughness nearly three times greater, than does the film of the straight solution. Pigments such as Prussian blue, chemically pure chrome greens, chrome yellows, toluidine red are mostly in favor and may be ground fine in castor oil in about the same proportion as if linseed oil were used. The proportion of paste color and celluloid varnish varies according to the nature of the protection desired, and the bulk of the paste. So for instance 4 oz. of Prussian blue will color one gallon of varnish, while from 6 to 8 oz. of dark chrome green and from 8 to 12 oz. of chrome yellow and 8 oz. of toluidine red are required.

Grinding Colors in Turpentine.

While not very often in demand, it will so happen, that for a special purpose, such grindings are specified. In order to avoid waste by evaporation and splashing, the grinding must be done on mills of slow speed, the stones being encased. Drop black, Prussian blue and ochers are rather hard to grind in turps, while white lead, zinc, lithopone and the chrome yellows, umbers and sienna are usually soft. Unless a small portion of a lubricant, such as oil or varnish is used in addition to the turpentine, the loss is entirely too great and it is next to impossible to obtain a smooth paste. The proportion of pigment, oil and turps required are about as follows, allowing for evaporation:

White lead:	90 pigment,	2 refined oil,	8 turps.
Zinc white:	72 "	5 "	23 "
Lampblack:	25 "	10 "	65 "
Prussian blue:	50 "	10 "	40 "
French ocher:	64 "	6 "	30 "
Chrome yellow, M:	60 "	5 "	35 "
" green, pure:	64 "	6 "	30 "
Bone black:	50 "	10 "	40 "
Umber and sienna:	45 "	10 "	45 "
Vandyke brown:	40 "	10 "	50 "

If any of these batches are to produce 100 pounds finished material, the portions of turps here given must be increased in the mixing by 10 per cent. at least.

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